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[No. 48.]

N. E. COTTON MANUFACTURERS' ASSOCIATION.

PROCEEDINGS

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OF THE

TWENTY-FIFTH ANNUAL MEETING,

HELD AT BOSTON,

APRIL 30, 1890.

PRECEDED BY

CATALOGUE OF MEMBERS.

BOSTON:
WRIGHT & POTTER PRINTING COMPANY,
18 POST OFFICE SQUARE.
1890.

[No. 48.]

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BOARD OF GOVERNMENT.

1890.

PRESIDENT.

WALTER E. PARKER, ... LAWRENCE, MASS.

VICE-PRESIDENTS.

ARNOLD B. SANFORD, ... FALL RIVER, MASS.
ROBERT McARTHUR, ... BIDDEFORD, ME.

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E. W. THOMAS, ... LOWELL, MASS.
WILLIAM H. WHITIN, ... WHITINSVILLE, MASS.
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ALFRED M. GOODALE, ... WALTHAM, MASS.

AUDITOR.

J. H. SAWYER, ... BOSTON, MASS.

SECRETARY AND TREASURER.

AMBROSE EASTMAN, ... BOSTON, MASS.

Office of the Association, 27 School Street, Boston.

MEMBERS OF THE ASSOCIATION.

1890.

HONORARY MEMBERS.

George Arms		New York City.
Benjamin F. Nourse		Boston, Mass.

ACTIVE MEMBERS.

Stephen I. Abbott	Lockwood Co.	Waterville, Me.
Alfred E. Adams	Whitinsville Cotton Mills	Whitinsville, Mass.
Charles T. Aldrich	Baltic Mills	Providence, R.I.
Henry L. Aldrich, Jr.	Baltic Mills	Providence, R.I.
William Ames	Fletcher Manuf. Co.	Providence, R.I.
Edmund L. Anthony	Border City Manuf. Co.	Fall River, Mass.
Edward Atkinson		Boston, Mass.
Edward W. Atkinson		Boston, Mass.
George Atkinson	Massachusetts Mills	Boston, Mass.
George Ashworth		Manchester, Eng.
H. C. Atwood	Williamsville Manuf. Co.	Killingly, Conn.
Edwin H. Baker	Otis Co.	Ware, Mass.
William P. Bancroft		Wilmington, Del.
A. D. Barker	Avon Manuf. Co.	Lewiston, Me.
Cyrus I. Barker	Avon Manuf. Co.	Lewiston, Me.
W. A. Barrell	Lawrence Duck Co.	Lawrence, Mass.
Stockton Bates	Bridesburg Manuf. Co.	Philadelphia, Penn.
George W. Bean	Androscoggin Mills	Lewiston, Me.
John Birkenhead		Mansfield, Mass.
N. B. Borden	Barnard Manuf. Co.	Fall River, Mass.
Richard B. Borden	Troy C. and W. Manuf. Co.	Fall River, Mass.
Thomas J. Borden	American Print Works	Fall River, Mass.
Thomas S. Borden	Metacomet Mills	Fall River, Mass.
E. S. Boss	Willimantic Linen Co.	Willimantic, Conn.
James M. Bourne	Lowell Bleachery	Lowell, Mass.
Stephen N. Bourne	Stark Mills	Manchester, N H.
Erastus Boyden	Prescott Mills	Lowell, Mass.
B. C. Brainard	Washington Manuf. Co.	Gloucester City, N.J.
Edward A. Brigham		Boston, Mass.
O. S Brown	Salmon Falls Manuf. Co.	Salmon Falls, N.H.
E. C. Bucklin	Interlaken Mills	Providence, R.I.
Edward N. Burke		Lowell, Mass.

William D. Cadwell	Jackson Co.	Nashua, N.H.
George Callaghan	Angora Mill	Philadelphia, Penn.
Samuel R. Campbell	New York Mills	New York City.
Byron F. Card	New Bedford Manuf. Co.	New Bedford, Mass.
George A. Chace	Bourne Mills	Fall River, Mass.
Simeon B. Chase	King Philip Mills	Fall River, Mass.
Thomas C. Chandler	Windham Cotton M'f'g Co.	Willimantic, Conn.
George A. Clark	Manchester Mills	Manchester, N.H.
Jeremiah Clark		Lowell, Mass.
Alfred Clarke		Lowell, Mass.
F. E. Clarke	Pemberton Co.	Lawrence, Mass.
Alonzo A. Coburn		Lowell, Mass.
J. G. Coburn	Hill Manuf. Co.	Lewiston, Me.
John A. Collins	American Linen Co.	Fall River, Mass.
J. Andrew Comstock	Uncasville Manuf. Co.	Uncasville, Conn.
A. S. Covel	Tremont and Suffolk Mills	Boston, Mass.
A. G. Cumnock	Boott Cotton Mills	Lowell, Mass.
Andrew J. Currier	Albion Mills	Albion, R.I.
A. Dahlgren	National Manuf. Co.	Nashville, Tenn.
A. W. Danforth	Shanghai Cot. Cl'h Mill Co.	Shanghai, China.
Woodbury K. Dana	Banner Mill	Saccarappa, Me.
John W. Danielson	Quinebaug Co.	Providence, R.I.
E. S. Davis	Continental Mills	Lewiston, Me.
Henry A. Davis		Lowell, Mass
B. D. Davol	Pocasset Manuf. Co.	Fall River, Mass.
James Dempsey	Lewiston Bleachery	Lewiston, Me.
William P. Dempsey	Dempsey Bleachery	Pawtucket, R.I.
E. P. Dennis		Lowell, Mass.
Charles A. Denny		Leicester, Mass.
George Dexter	Pepperell & Laconia Cos.	Boston, Mass.
Eben S. Draper		Hopedale, Mass.
George A. Draper		Hopedale, Mass.
William F. Draper		Hopedale, Mass.
Joseph Dronsfield	Fletcher Manuf. Co.	Providence, R.I.
David H. Dyer	Quequechan Mills	Fall River, Mass.
Isaac Eaton		Nashua, N.H.
Lawrence V. Elder	Maginnis Cotton Mills	New Orleans, La.
Frederick W. Ely	Falls Co.	Norwich, Conn.
Herbert R. Farnum	Bernon Manuf. Co.	Georgiaville, R.I.
William Firth		Boston, Mass.
Charles H. Fish	P. C. Cheney Co.	Manchester, N.H.
Herbert Fisher		Taunton, Mass.
M. F. Foster	Denison Cotton Manuf. Co.	Denison, Tex.
Philip H. Fowler	Gloucester Gingham Mills,	Gloucester, N.J.

William B. Gambrill	Druid Co.	Baltimore, Md.
William Gammell, Jr.	Berkeley Co.	Providence, R.I.
A. J. Gardiner	Danielsonville Cotton Co.	Danielsonville, Conn.
James G. Garland		Biddeford, Me.
Richard Garsed	Wingohocking Mills	Philadelphia, Penn.
James A. Gary	Alberton Cotton Mills	Baltimore, Md.
John Gegenheimer	Cordis Mills	Millbury, Mass.
Charles E. Getchell		Palmer, Mass.
Charles J. Goodwin	Indian Orchard Mills	Indian Orchard, Mass.
Alfred M. Goodale	Boston Manuf. Co.	Waltham, Mass.
David Gowdey		Providence, R.I.
William B. Gowdey		Providence, R.I.
William B. Gray		Boston, Mass.
Benjamin Greene	Cabot Manuf. Co.	Brunswick, Me.
Stephen Greene	Whitefield Mills	Newburyport, Mass.
William C. Greene	Thorndike Co.	Thorndike, Mass.
Frederick Grinnell		Providence, R.I.
Arthur H. Gulliver	Grosvenor Dale Co.	Grosvenor Dale, Conn.
Z. D. Hall,	Berkshire Cotton Manuf. Co.	Adams, Mass.
H. P. Hammett	Piedmont Manuf. Co.	Greenville, S.C.
John F. Hamlet	Manville Mills	Manville, R.I.
J. O. Hannum	Victory Mills	Saratoga, N.Y.
C. M. Harris, Jr.	Oakdale Shirt Manuf. Co.	Oakdale, Mass.
Frank Harris	Hamlet Mills	Woonsocket, R.I.
Henry F. Harris	West Boylston Manuf. Co.	Worcester, Mass.
Frank Haskell	Westbrook Manuf. Co.	Saccarappa, Me.
William Hayes	Barker Mill	Auburn, Me.
Jefferson Higgins		Augusta, Me.
J. G. Hill	Lawrence Manuf. Co.	Lowell, Mass.
Charles H. Hobbs	Slatersville Manuf. Co.	Slatersville, R.I.
John Holland	Cocheco Manuf. Co.	Dover, N.H.
Stephen Holman		Holyoke, Mass.
Gideon F. Holmes	Plymouth Cordage Co.	No. Plymouth, Mass.
George W. Holt, Jr.	Monohansett Manuf. Co.	Putnam, Conn.
William Hooper	Atlantic Cotton Mills	Boston, Mass.
John Hopkinson	Mississippi Mills	Wesson, Miss.
Elisha H. Howard	Harris Manuf. Co.	Providence, R.I.
Henry S. Howe		Boston, Mass.
David L. Jewell	China,Webs'r&Pemb'keM.	Suncook, N.H.
William C. Jillson	Hop River Manuf. Co.	Willimantic, Conn.
D. W. Johnson	Monadnock Mills	Claremont, N.H.
D. J. Johnston	Harmony Mills	Cohoes, N.Y.
Roland R. Kelly	Wampanoag Mills	Fall River, Mass.
Joseph H. Kendrick		Providence, R.I.

George E. Kent. . .	Pittsfield Mills	Pittsfield, N H.
Hervey Kent . . .	Exeter Manuf. Co. . . .	Exeter, N.H.
William J. Kent . .	Grinnell Manuf. Co. . .	New Bedford, Mass.
John Kilburn . . .	Lawrence Manuf. Co. . .	Lowell, Mass.
H. C. Kimball . . .	Blackstone Manuf. Co.. .	Blackstone, Mass.
John M. Kimball . .	29 Thomas St..	Lewiston, Me.
J. H A. Klauder . .	. . . . .	Philadelphia, Penn.
A. F. Knight. . . .	Lonsdale Co.	Ashton, R I.
Walter B. Knight . .	Bozrahville Manuf. Co. .	Bozrahville, Conn.
Harold Lawton . . .	Lapham's Mill	Centreville, R.I.
Frederick A. Leigh .	. . . . .	Boston, Mass.
Charles W. Lippitt .	Social Manuf. Co. . . .	Providence, R.I.
Henry Lippitt . . .	Social Manuf. Co. . . .	Providence, R.I.
Henry F. Lippitt . .	Globe Mill	Providence, R.I.
Robert W. Lord . .	. . . . .	Kennebunk, Me.
Charles L Lovering .	Whittenton Manuf. Co. .	Taunton, Mass.
Ernest Lovering . .	Lyman Mills	Holyoke, Mass.
Henry M. Lovering .	Whittenton Manuf. Co.. .	Taunton, Mass.
Arthur H. Lowe . .	. . . . .	Fitchburg, Mass.
J. S. Ludlam. . . .	Merrimack Manuf. Co.. .	Lowell, Mass.
Alvin S. Lyon . . .	Lowell Manuf. Co. . . .	Lowell, Mass.
W. H. Magee . . .	Berkeley Mill	Ashton, R.I.
Charles T. Main . .	Pacific Mills	Lawrence, Mass.
Charles R. Makepeace	. . . . .	Providence, R.I.
Charles H Manning .	Amoskeag Manuf. Co. . .	Manchester, N.H.
Henry F. Mansfield .	Mohawk Valley Mills . .	Utica, N.Y.
Albert G. Martin . .	P. O. Box 195	Eufaula, Ala.
Rufus A. Maxfield .	. . . . .	Lowell, Mass.
Thomas Mayor . . .	. . . . .	Providence, R.I.
Robert McArthur . .	Pepperell & Laconia Cos.	Biddeford, Me.
Wm. H. McDavitt. .	Appleton Co.	Lowell, Mass.
Charles D. McDuffie .	Manchester Mills . . .	Manchester, N.H.
Fred. C. McDuffie . .	Everett Mill	Lawrence, Mass.
John Tempest Meets.	. . . . .	Taunton, Mass.
Frank M. Messenger.	Grosvenor Dale Co.,	North Grosvenor Dale, Conn.
James H. McMullan .	. . . . .	Biddeford, Me.
Timothy Merrick . .	Merrick Thread Co.. . .	Holyoke, Mass.
Oliver H. Moulton .	Hamilton Manuf. Co. . .	Lowell, Mass.
J. Turner Morehead .	. . . . .	Leaksville, N.C.
W. H. Munroe . . .	41 Harrison Street . . .	Providence, R.I.
Franklin Nourse . .	York Manuf. Co..	Saco, Me.
E. H. Nutting . . .	Hooksett Manuf. Co. . .	Hooksett, N.H.
Warren M. Orswell .	Shirley Yarn Co..	Shirley, Mass.

John C. Palfrey . .	Manchester Mills . . .	Boston, Mass.
Francis J. Parker . .	Monadnock Mills . . .	Boston, Mass.
Walter E. Parker . .	Pacific Mills	Lawrence, Mass.
John H. Parks . . .	New Brunsw'k Cotton Mills,	St. John, N.B.
Theophilus Parsons .	Lyman Mills	Boston, Mass.
William D. Pennell .	Hill Manuf. Co.	Lewiston, Me.
Haven C. Perham		Lowell, Mass.
John M. Pevey		Lowell, Mass.
Moses Pierce . . .	Norwich Bleachery . . .	Norwich, Conn.
Charles H. Plummer .	Great Falls Manuf. Co. .	Great Falls, N.H.
Walter Pollard		Crompton, R.I.
Thomas C. Powell		Providence, R.I.
H. L. Pratt	Bates Manuf. Co. . . .	Lewiston, Me.
Thomas Pray, Jr.		Boston, Mass.
J. E. Prest		Whitinsville, Mass.
A. M. Pulsifer . . .	Barker Mill	Auburn, Me.
M. W. Quinn . . .	Hamilton Woolen Co. . .	Amesbury, Mass.
T. G. Ramsdell . . .	Monument Mills	Housatonic, Mass.
Robert Redford . .	Arlington Mills	Lawrence, Mass.
James Renfrew, Jr. .	Renfrew Manuf. Co. . .	Adams, Mass.
Roscoe C. Reynolds		Lewiston, Me.
F. H. Rice		W. Boylston, Mass.
Chas. H. Richardson .	Appleton Co.	Lowell, Mass.
Howard Richmond .	Crompton Co.	Providence, R.I.
Charles E. Riley		Boston, Mass.
Louis Robeson . . .	Appleton Co.	Boston, Mass.
H. Saltonstall . . .	Pacific Mills	Boston, Mass.
Arnold B. Sanford .	Globe Yarn Mill	Fall River, Mass.
J. H. Sawyer . . .	Newmarket Manuf. Co. .	Boston, Mass.
John Scott	Willimantic Linen Co. . .	Willimantic, Conn.
E. M. Shaw	Nashua Manuf. Co. . . .	Nashua, N.H.
Thomas C. Sheldon .	Sawyer Mill	Boylston, Mass.
George E. Sherman .	Valley Falls Co.	Valley Falls, R.I.
William F. Sherman .	Atlantic Cotton Mills . .	Lawrence, Mass.
Charles M. Shove . .	Granite Mills	Fall River, Mass.
Francis H. Silsbee . .	Pacific Mills	Lawrence, Mass.
Arba C. Slater . . .	Linwood Mills	Whitinsville, Mass.
Robert R. Smith . .	Greenwoods Co.	New Hartford, Conn.
Wm. S. Southworth .	Mass. Cotton Mills . . .	Lowell, Mass.
William I. Spear		Nashua, N.H.
S. S. Spencer . . .	Conestoga Steam Mills .	Lancaster, Penn.
Geo. R. Stearns . .	Riverside Mills	Augusta, Ga.
B. T. Stephenson . .	Waltham Bleachery . .	Waltham, Mass.
Wilbur A. Stiles . .	620 Atlantic Ave. . . .	Boston, Mass.

Joseph Stone . . .	85 Milk St.	Boston, Mass.
Herman F. Straw . .	Amoskeag Manuf. Co. . .	Manchester, N.H.
James O. Sweet . .	Ashland Cotton Co. . . .	Jewett City, Conn.
Edward P. Taft . .	Ponemah Mills	Providence, R.I.
Charles F. Tarbell .	620 Atlantic Ave. . . .	Boston, Mass.
George P. Taylor . .	Lancaster Mills	Clinton, Mass.
Richard Thackeray .	Weetamoe Mills	Fall River, Mass.
Earl A. Thissell . .	. . . . .	Lowell, Mass.
Ariel C. Thomas . .	Clinton Manuf. Co. . . .	Woonsocket, R.I.
Charles E. Thomas .	Clinton Manuf. Co. . . .	Woonsocket, R.I.
E. W. Thomas . . .	Lowell Hosiery Co. . . .	Lowell, Mass.
D. M. Thompson . .	Mills of B. B. & R. Knight,	Providence, R.I.
Samuel J. Thompson .	Valatie Cotton Mills . .	Valatie, N.Y.
Osmon B. Tilton . .	Lynchburg Cotton Mills .	Lynchburg, Va.
William E. Trainer .	Linwood Mills	Linwood Sta., Penn.
Edmund E. Truesdell,	China,Webs'r&Pemb'keM.	Suncook, N.H.
James Waring . . .	Narragansett Mills . . .	Fall River, Mass.
John Waterman . .	Warren Manuf. Co. . . .	Warren, R.I.
J. W. Wattles . . .	. . . . .	Canton, Mass.
T. B. Wattles . . .	. . . . .	Suncook, N.H.
George W. Weeks .	Lancaster Mills, ...	Clinton, Mass.
John Walter Wells .	Millville Manuf. Co. . .	Woodbury, N.J.
Henry F. West . . .	. . . . .	Gloucester, N.J.
Channing Whitaker .	. . . . .	Lowell, Mass.
A. Tenny White . . .	. . . . .	Biddeford, Me.
Harry T Whitin . .	Rockdale Mill	Northbridge, Mass.
William H. Whitin .	Whitin Manuf. Co. . . .	Whitinsville, Mass.
A. N. Whiting . . .	Whiting Mills	Oakdale, Mass.
William S. Whitney .	Pocasset Manuf. Co. . .	Fall River, Mass.
E. B. Wilber . . .	. . . . .	Uncasville, Conn.
Henry M. Wilcox . .	John Rhodes Warp Mill .	Millbury, Mass.
Theop. W Wilmarth .	Rockdale Mills	Northbridge, Mass.
Thomas Wilmarth . .	. . . . .	Adams, Mass.
A. S. Winslow . . .	Crompton Co.	Crompton, R.I.
George Wood . . .	Millville Manuf. Co. . .	Philadelphia, Penn.
C. J. H. Woodbury .	. . . . .	Boston, Mass.
Daniel Wright . . .	56 Marion St.	E. Boston, Mass.

Total number of Honorary Members 2
Total number of Active Members 244

CALL FOR MEETING.

Boston, April 10, 1890.

Dear Sir: The stated annual meeting of the Association will be held at the Massachusetts Institute of Technology, Boylston Street, Boston, on Wednesday, April 30, at 10 o'clock a.m., for the choice of officers for the ensuing year, and the transaction of such other business as shall properly come before it.

The Board of Government will submit, for discussion and action, the following proposed vote: —

That it is the sense of this Association that certain statistics concerning the production of goods, and the cost per pound of labor, in the mills represented in the Association, would be of great interest and value; and that the Board of Government is hereby authorized to inaugurate a system whereby such information can be obtained; the expense per annum not to exceed dollars.

The Board has the pleasure to announce the following topics for consideration, in addition to former subjects, which will be in order if called up by any member: —

Mr. R. Guastavino of Boston, Mass., will present a paper descriptive of his new Building Material, adopted for the Boston Public Library and other structures.

Mr. W. V. Wallace of Hinsdale, Mass., representing the Wallace Manufacturing Company, will explain their system of Moistening the Air in Mills.

Copies of these two papers will be printed in advance of the meeting, and supplied to any member who shall apply for them to the Secretary.

By vote of the Board of Government,

AMBROSE EASTMAN,
Secretary.

PROCEEDINGS.

Pursuant to the foregoing notice, the stated annual meeting of the NEW ENGLAND COTTON MANUFACTURERS' ASSOCIATION was held at the Massachusetts Institute of Technology, on Wednesday, April 30, 1890, at 10 o'clock A.M.

The President, Mr. WALTER E. PARKER, occupied the chair.

The call for the meeting was read by the secretary.

Upon motion, the following were appointed a committee to nominate officers of the Association for the ensuing year: —

Messrs.	RICHARD B. BORDEN,	Fall River, Mass.
	HERVEY KENT,	Exeter, N. H.
	H. L. PRATT,	Lewiston, Me.
	GEO. W. HOLT, JR.,	Putnam, Conn.
	A. J. CURRIER,	Albion, R. I.

The Secretary presented his annual report, together with those of the Treasurer and the Auditor.

Voted, That the reports be accepted and placed on file.

The PRESIDENT. The reports of the Secretary and Treasurer seem to suggest some things that ought to be discussed at this time, and the Chair will be glad to hear from any member. The reproduction of copies of the proceedings from the organization of the Association to the present time is a matter you are asked to consider.

Mr. GREENE. I would like to inquire of the secretary what the cost will be.

The SECRETARY. The rates might be reduced somewhat by competition. These parties suggest printing in instalments of one to ten numbers; varying the number according to the size of the different reports. The estimate for reprint-

ing eleven numbers, 1 to 11 inclusive, for fifty copies, would be $610.20, and for 300 copies, $656. The next estimate, for numbers 12 to 19, $524 for fifty copies, or $566 for three hundred copies. The others are to be the same proportionately.

The PRESIDENT. At what time was the index made?

The SECRETARY. It covers thirty-seven of the reports.

The PRESIDENT. Probably the proceedings could be printed in two volumes, up to and including that part that would make the index good for that time.

Mr. R. R. SMITH. I should like to inquire, Mr. Chairman, what is the demand for these extra copies? Are these intended for circulation among the members, or are they to be kept among the papers of the Association? Has the Association now a complete set?

The SECRETARY. The Association will have a complete set if they accept Mr. Parker's offer to give those he has. That would be but one. We had ten to one hundred sets before the fire. Those are gone. The only copies we should have, except from reprints, would be furnished by members. The difference in cost between a few and many is very small. The difference between fifty and three hundred is only for the press work, — a difference of $45 or $50. Each member would then have an opportunity to complete his files.

The PRESIDENT. The desirability of having a complete file of the proceedings of the Association is evident. This Association is expected to grow, and members will be coming in who will doubtless want a complete file of the proceedings. This is the chief reason for reproducing at the present time. Then there are calls from various members, from libraries, from associations, and perhaps from individuals outside of this Association, for copies. Such as are supplied to non-members have been disposed of at, I think, five dollars.

The SECRETARY. Two dollars and one-half.

The PRESIDENT. Two dollars and one-half apiece when called for by parties not belonging to the Association. I do

not know that the Association is ready to vote to reproduce them at the present time; but it seems to me the time will come when they will be wanted.

A MEMBER. Did the estimate which the secretary read, cover two volumes to No. 37?

The SECRETARY. The estimate was for the first eleven numbers, in one volume, and, for the second volume, the next ten numbers; these giving about an average number of pages. They would be bound in paper.

On motion of Mr. WOODBURY, —

Voted, That the question of reprinting the past transactions of the society be referred to the Board of Government, with power to act.

The PRESIDENT. The nominating committee is ready to report.

The chairman of the committee, Mr. BORDEN, reported as follows: Your committee decided to drop one name from the Board of Directors, — Mr. S. S. SPENCER of Lancaster, Penn. He lives at so great a distance that he could not attend the meetings, and so wished his name to be dropped. The nominations are as follows: —

President — WALTER E. PARKER, Lawrence, Mass.

Vice-presidents — ARNOLD B. SANFORD, Fall River, Mass.; ROBERT MCARTHUR, Biddeford, Me.

Directors — O. S. BROWN, Salmon Falls, N. H.; STEPHEN N. BOURNE, Manchester, N. H.; ALFRED M. GOODALE, Waltham, Mass.; ROBERT R. SMITH, New Hartford, Conn.; E. W. THOMAS, Lowell, Mass.; WILLIAM H. WHITIN, Whitinsville, Mass.

Mr. BOURNE. I would like to resign, and have a better man elected. My train was late, or I should have seen the committee.

The PRESIDENT. The names will be acted upon by the Association, as presented by the committee.

Mr. BORDEN. I move that the secretary be instructed to cast a vote for the Association.

The motion was adopted.

The PRESIDENT. The secretary has cast the vote, as suggested, and the gentlemen named by the committee are unanimously elected.

I wish to thank you for the re-election. I somewhat expected a change would be made, but I will try to serve you for another year.

The next business in order on the call for the meeting is the following proposed vote: —

That it is the sense of this Association that certain statistics concerning the production of goods, and the cost per pound of labor, in the mills represented in the Association, would be of great interest and value; and that the Board of Government is hereby authorized to inaugurate a system whereby such information can be obtained, the expense per annum not to exceed dollars.

A few years ago, such a system was inaugurated by the Board of Government, on the suggestion, I think, of Mr. Lippitt of Providence, for an investigation into the methods and cost of picking in twenty-five or thirty mills in New England. The investigation was made by Mr. REED, under the supervision of a committee representing the Board of Directors; and he presented a valuable paper to the Association. Such statistics from the mills represented in this Association would be of value. The methods employed; the different kinds of machinery, all producing the same or similar results; and the cost of production, if studied by some competent person, it seems to me would be something every member of this Association would like to see; and I can hardly see why any member of this Association should hesitate to give that information. You will remember that the investigation in regard to picking was so made that, while each mill was known to the investigator, no one else could tell what mill was represented; and that same system could be maintained. The Board felt unanimous in this matter, but wanted to test the sense of the meeting; because they did not wish to spend money or enter upon the work without the full consent of the Association. I hope you will consider the matter, and that it will come up for discussion.

The Board of Government has not considered such a work in detail, but simply advocates at this time a general plan to be worked up by some committee, which shall give the information, that I am sure we all desire, concerning important processes of manufacturing, without disclosing, of course, the *entire* cost, etc., of any completed fabric.

After a brief discussion, in which some opposition was expressed, it was voted that this subject be indefinitely postponed.

The PRESIDENT. The matter of nominations for membership will now be taken up.

The SECRETARY. The following names have been proposed, and are recommended by the Board of Government for election: —

JOHN GEGENHEIMER,	Millbury, Mass.
WILLIAM B. GOWDEY,	Providence, R. I.
J. O. HANNUM,	Saratoga, N. Y.
HENRY F. HARRIS,	West Boylston, Mass.
CHARLES R. MAKEPEACE,	Providence, R. I.
HENRY F. MANSFIELD,	Utica, N. Y.
GEORGE R. STEARNS,	Augusta, Ga.

The PRESIDENT. You have heard the nominations made by the Board of Directors. Shall they be voted on singly? If I hear no objection, the vote will be taken on the names as proposed.

All of the nominees were thereupon elected to membership.

The next matter on the call for the meeting is a paper by Mr. Guastavino of Boston, Mass., on a new building material adopted in the Boston Public Library and other buildings.

Mr. WOODBURY. Before that paper is read, I wish to offer the following motion: —

Voted, That the Board of Directors be authorized to lay an assessment on the members of the Association, not to exceed ten dollars each, to defray the expenses of the ensuing year.

The motion was adopted.

THE COHESIVE SYSTEM OF BUILDING.

By R. Guastavino, Architect, Boston, Mass.

I have heretofore treated, in other addresses, the general subject of the cohesive system of building; but, accepting the invitation of your board of government, I take pleasure in making special reference, in this paper, to its application to industrial buildings, which I hope will prove of interest.

This work will not require great ability in me, for I come from a country which, like New England, breathes in industrial activity, in cottons, woollens, silks, laces, etc.; a country which, not only because it supplies its own market, but because of its export trade, more especially to South America, East India and North Africa, is known as the "Spanish Manchester." I refer to Barcelona, Catalonia, Spain, a country where I had for fifteen years my circle of operations as architect and specialist in this kind of building; hence I can modestly say that I have not to talk about that which is new to me, nor will it be new to all of my auditors. All that I shall do is to explain what has been done in the last twenty or twenty-five years, so that the Catalonians now have nearly seventy-five per cent. of their industrial buildings fire-proof.

How was this done? Was it because these industries were backed by larger capital, had better facilities, or made more profit than those of New England? What is the reason that the Catalonian manufacturers have ceased making other than fire-proof buildings? Why do not the New England manufacturers do the same? Those questions I want to analyze and answer.

As far back as 1865 we can say that neither in Barcelona nor in the provinces of Catalonia was there a single factory that was not constructed, as here, all wooden floors, and

most of them wooden columns and girders; they also had to some extent the "slow-burning" construction, — a combination of wood and iron. I remember that all the factories in the streets of Amalia Rierretta, Luna, and the districts of San Pablo and San Pedro, were of wood. So old and so saturated with oil were these buildings, that the smell arising was foreboding of immediate danger, perhaps caused by the knowledge of the scene of horror which would ensue, should there be the least neglect, by fire. Nearly all of these buildings have disappeared, their owners, with better judgment, have built their factories less closely together, and in another system, better suited to their interest, — that is, fire-proof.

Some may imagine that the manufacturers of these places were richer or safer in their investments, thus requiring more permanent and safe buildings; but it is not so, as we are afforded very little protection, our markets being open to the French and English manufacturers, and any slight change of the tariff threatens immediate danger. What was the cause of this change?

These manufacturers had learned from experience, that, notwithstanding the insurance money comes, in case of fire, the factory must be stopped for a period, the customers must be supplied, and they go to some competing firm; so that, when they get started, it is to begin over again. They also know that the wear and tear and depreciation in a wooden building in five years pays the extra cost of a fire-proof one. A factory costing $20,000, requiring to be built in twenty years, means that five per cent. per annum must be laid away to restore it at that time. This means that in five years the factory costs $25,000, or as much as a fire-proof one. All these considerations, and the increasing exigencies of the fire insurance companies rendering them more careful in the issuing of policies, compelled the manufacturers to open their eyes to the value of fire-proofing; and under these pressing necessities some of them decided at once to build their factories fire-proof.

But twenty-five years ago the Catalonian manufacturers were in the same position as those of New England; they knew only the English fire-proof factories of iron and small brick arches, expensive, and not fire-proof, with the difficulties connected with this system regarding the running of shafting, in which any of the frequent alterations required in every factory is an enormous task. Realizing this inconvenience, the manufacturers of Catalonia did not at a single bound go from one extreme to the other, — that is, from the poorest to the most expensive; they took precautions so that the sudden change might not nauseate them, and commenced to study the way to overcome the inconveniences of the English system of fire-proof industrial buildings, and find such a system as was fitted for the manufacturers' convenience, and to avoid the heavy losses which the insurance companies are not required to pay. No one can blame this prudence, for the capital invested in the factory is the manufacturers' tools, like the hammer and chisel in the hands of the workman; they cannot, they must not, employ more than just what is necessary, with the least chance of loss; and because of their prudence they now have, as I have said, more than seventy-five per cent. of their buildings really fire-proof.

This system of fire-proofing was the combination of clay and wood or clay and iron, with ten feet six inches or more span, according to the bays. I must remark that, for every ten fire-proof factories, eight were constructed of clay and wood, and two of clay and iron. The adopting of this combination of wood and clay, in preference to iron and clay, was not so much due to economy as to the belief that in the way applied it was better fire-proof, besides being more adaptable and convenient for changes and alterations, reducing wood, however, to the lowest quantity, and putting it under absolutely safe conditions. One of these was the firm of Battlo Bros., for whom I built the first factory as architect in this way in Sarria, as shown in these photographs. This was so eminently successful that several others were at once erected on the same principle.

Now, gentlemen, if these men had not been prudent in this matter, and, instead of making this combination, had been extravagant in adopting the heavy iron and heavy clay as in the English system, they would have secured improvements in name, but not in fact; for cash is the key to the situation, and, although the manufacturer has noble aspirations for progress and improvement, he knows that he must maintain prudential limits.

I have enlarged on this point; for it is a general defect, that, when we see a new thing, our natural inclination is to go to the extreme and reach after the impracticable, thus making no progress.

Thus was established in Catalonia two systems of fireproof factories: the one type shown in the factory of Vidal Hijos, constructed 1871, the spindle building of Battlo Bros., 1869, and several others; the other type shown in the loom room of Battlo Bros., woollen factory of Carreras, etc. The first type consists of wooden girders and tile arches, and the second has tile arches for ribs, with small iron beams with dome between. Sections shown on plan.

What is the combination, — iron and clay, or wood and clay? It is very simple; it is only iron or wooden girders, set apart over columns at the regular distance of a factory bay, ten feet six inches or more, as has been stated, and between them tile arches, similar to those now to be seen in the Boston new public library, or the Harcourt building, or Exeter Chambers.

The combination with iron can be executed in two ways, as it is used in some of the rooms of the library, acting as a beam or girder, working by deflection; or as used in the Colorado Telephone Company's building, Denver, Y. W. C. A., New York, working principally by tension. This latter form may also be seen in some of the rooms of the library. When the combination is of wood, it is working in deflection, as in the case of iron, and in some cases by tension. The construction is cheapest in both materials when working by tension.

Some may think that fire-proofing in Catalonia is cheaper than here; that, in a general sense, is not so, because, supposing they had accepted the English system, the relation between the English system and the cohesive system would be the same there as here. It may be supposed that the cohesive system is dearer here than there. I will show wherein the difference lies. It cannot be in labor, as the same proportion of difference exists in the wages of carpenters for wooden construction as for masons; and, as the walls are the same in either case, the difference is only in the floors; and, if any there be, it must be in the material. Wood is the same there as here. Portland cement, one of the main factors in the construction, costs in Spain three dollars a barrel, against two and one-half dollars here. Plaster costs about the same. The difference is only in the cost of the tile, which in Spain can be purchased at five dollars per thousand, while costing here fifteen dollars; but, taking into consideration the fact that in Spain we use five-eighths inch and here one inch in thickness, and that the tile is only one of the components, and that it is only in this special material that the cost is greater, the real difference in the price per foot of the material is only twenty-five per cent. This twenty-five per cent. difference in the cost of materials cannot be a sufficient reason for not using the construction here; for, in a factory one hundred by one hundred feet, or ten thousand square feet, the difference in the floors would only be eight hundred dollars. I do not think this eight hundred dollars would prove an insurmountable obstacle to a New England manufacturer, therefore this cannot be the cause. In the iron there is a little disproportion; but, as the economic state of a country is relative in all things, if the iron and construction is cheaper, the production is also cheaper and the income and interest less, so that does not affect this comparison; consequently, the difference in cost there and here between the wooden and fire-proof factories is really the same, and the reason for not adopting the same system here is not due to the difference of eight hundred dollars for each ten thousand feet of floor.

We can now build the arches sufficiently light and strong with enough span to bridge a large bay, and can use iron girders or wood, with clay. Both of these have their advantages, especially the latter: —

First. Avoiding heavy construction of brick.

Second. Enlarging the span so as to bridge from bay to bay ten, twelve, fifteen feet or more.

Third. Avoiding the inconvenience in setting shafting, giving the same facilities as though all wood.

As regards the arches themselves, they can be seen in every form and combination in the new library, as was explained in my lecture in this building of Oct. 24, 1889. This construction consists of a combination of clay tiles and Portland cement, forming in itself an artificial stone of the shape which experience advises, selecting in each case the most convenient form, knowing that on this depends the economy and strength of the arch. To give a more practical idea of this element of construction, I may say that it is nothing more than a conglomerate; and I think that you are all aware of what the term conglomerate implies, — that is, a stone composed of small chips united together by nature with sediments of lime, silicate or aluminum, or a combination of these. We have examples of this all about Boston; the principle is the same, the only difference is in the process or *modus operandi*, so as to obtain rapidity, economy and lightness inside of the maximum strength, and to secure this we use clay tiles and Portland cement, forming practically an artificial stone.

Criticisms on the System.

Many discussions have arisen both in favor of and against the cohesive system in the last months, as is natural when any new application is brought forward in the arena of scientific discussion; but it is frequently seen that the greatest friends of the system sometimes go too far in their enthusiasm and favor of the new idea, the result being that in their hands it is disfigured or erroneous.

For instance, it is said: —

First. That the arches under this system have no thrust. This is correct, and not correct, as I will prove afterwards.

Second. It is said that the system is more expensive than any other system of fire-proofing, or that there is no economy in it. To this I will answer that it depends on the forms adopted in the system.

Fig. 1.

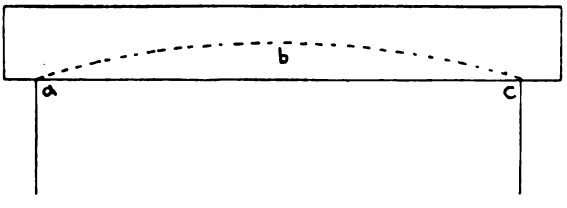


Fig. 2.

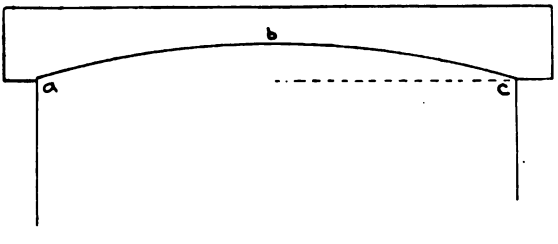
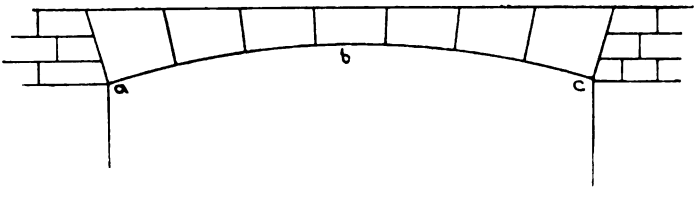


Fig. 3.



Third. That the ceilings of this construction require greater height than others; consequently, it is necessary to

build every room with high ceilings, and this of course causes the building to be higher. That seems to be so, surely, because some people may have seen some arches or ceilings that have been constructed specially with a high rise, to give more constructive lines; and they thought that all the ceilings must have a similar rise; when the truth is, that it entirely depends on the wishes of the architect who is applying the system.

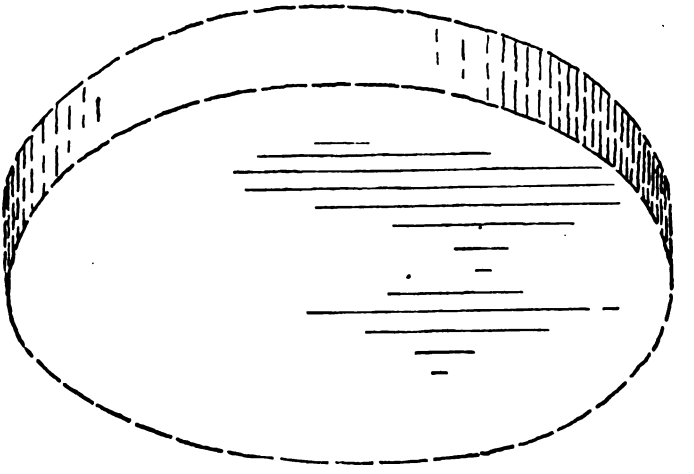
In answer to the first, I will say that the thrust depends on the form and not on the material. Suppose we take a lintel of stone, as in Fig. 1; if we put it as in Fig. 1, practically we have no thrust. If we take another lintel, Fig. 2, that is like the first one; but, taking off the material under the curved line A, B, C, Fig. 2, we have some thrust at once. You can see, without any demonstration, that in the second case we have thrust and in the first one we have comparatively none. This does not mean that in the first case it absolutely does not exist, because inside of any lintel we must consider an arch when it is working; in the same way that in any block of stone or any block of marble or any block of wood we know exists the most ideal figure that the imagination can conceive, — the question is to take away the shell that involves it. In the same way in any piece of wood or in any block of stone we have an arch better than which the most exact mathematician cannot define; and, as soon as we put a lintel to work, this imaginary arch is put into action, and all of the material under this arch is working to take off the thrust, because it is the rod of this imaginary arch. Now, if we take away this material (which is the condition in the second case), as the material which is working as a rod is not there, the arch is more free for weight and thrust.

But we have a third case; suppose Fig. 3, — this is not a lintel where we take the lower part of the material forming, as in the rest, an arch, — this is a regular arch, formed by pieces; it is not necessary to demonstrate that this has thrust, but in this case the thrust is in full; permit me to

use these terms, —I mean in full, because, in the second case, the stone lintel being cut in a curve, it is not as free as in the third, because to get any signs of thrust it is necessary to break the lintel; consequently, the effect of the thrust will begin when the resistance to the cohesion of the stone is finished, whereas in the third case this commences at once, because it is in several pieces and there is no cohesion.

Now, gentlemen, our barrel arches are working in the second case; I remark barrel arches because the domes are more advantageous.

Fig 4.



We are going to suppose the case of domes. The dome is the genuine form of cohesive system. Suppose Fig. 4, a big block of stone, say ten feet in diameter, and one foot, or one foot six inches, thick; if we support that on the four sides just as a lintel, we have practically no thrust, and if we make a cavity on the under side, Fig. 5, making a curve like a dome, we will have a dome arch, but will have no thrust. It is not the second case of the lintel, that is, taking off the material that is working as a rod the thrust commences to act. In this case of the dome it is not so, because the material that is working as a rod, that is, by

tension, is formed into rings which remain as in rings. This is our case, if we build the ceilings in the form of domes; and if it is well applied and properly built, practically we have no thrust; consequently, it is necessary to well understand the distinct cases, and not make confusion.

Fig. 5.

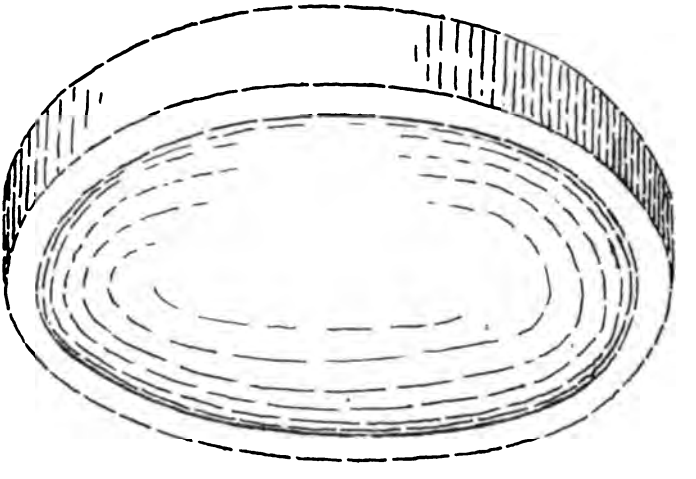
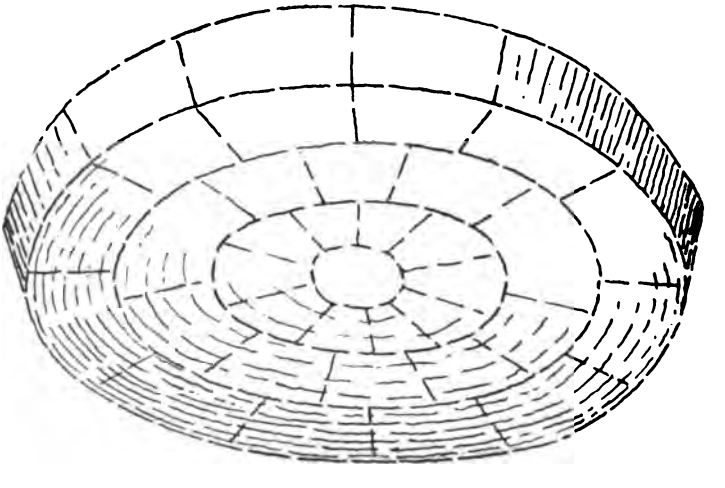


Fig. 6.



The answer to the statement that it is so expensive that it cannot be used in competition with the slow-burning construction is as follows: —

First. As we have demonstrated before in this last case, that is, that the barrel arch has some thrust, and requires some material to counterbalance this, that is, rods, that is one of the causes which makes the barrel construction more expensive than the dome.

Second. The barrel arch requires two sides for the arch to rest on, such as girders or beams; these girders or beams must have the strength to support all the weight that the arch carries, besides the weight of the arch. The price of the girders or beams must be added to the price of the arch; consequently, we have the same inconvenience as in the regular fire-proofing, where the arches also rest against the beams, having only the advantage that our barrel arches are lighter, the span can be greater; consequently, these girders or beams can be lighter and cheaper. But, nevertheless, the fact remains that we must have the girders or beams, and the value of these must be added to the arch; the result is, that, if we have an economy over the ordinary fire-proofing, these barrel arches cannot compete with the slow-burning construction, in consequence of these heavy girders.

Third. But if, instead of using the barrel arches in the cohesive system, we use the domes in the same system, we have economy, if well applied, because we have not these two last inconveniences, — that is, the use of heavy rods between heavy girders, and the use of the girders or beams themselves.

Now, suppose we receive a plan, as is generally the case with barrel arches and girders, and we give a price which is more expensive than the combination of dome without the heavy girders and heavy rods; the result is, that it is not as cheap as other combinations that we have already built and are now building. Is it the fault of the system, or whose is the fault? The fault is, that it is not well applied.

I must remark with great satisfaction that we have commenced to receive from every part of the country plans from architects, some of them showing that this system is commencing to be well understood and appreciated at its just value.

In regard to the question of height, I can say that, notwithstanding we give ten per cent. rise as a rule in all of the arches, it does not mean that it cannot be less or greater; just as, in the ordinary system of beams, we know that the higher section we give to beams the more economical is the result. For instance, if in a floor ceiling of beams twenty-five feet span we use beams eight per cent. of the span, the ceiling would be cheaper than if we give five per cent. for an equal load; for, in the first case, with less pounds of iron, we have the same resistance. The same is the fact in the arches and domes; the more rise we give, the more economical they are. This means that we use the same rules as in general bridging; we can reduce to eight per cent. in ordinary construction; and, as the arched form gives opportunity for greater height to the ceiling in the middle, the result is that practically the ceilings are higher in our system than in any other system, taking only in the crown six inches, but descending on the side occupying the place of small corners in all the regular ceilings; consequently, I cannot see in what way this system takes up more room than any other.

Another consideration has arisen in discussion, which I will ask permission of this audience to let me answer; that is, the question in regard to the patents; that is, if the system is patentable, in what does the patent consist, and by what is the patent warranted? In the first place, I must say that, allowing that in a small portion of Spain and Italy a similar system was applied empyrically, and on a smaller scale, it is a fact that it is not applied in any modern public building in either place, because, as I say, it has only an empyrical application; nor has any academy a regular system or scientific method for the right application of it.

This is due to the fact that the system was not perfected, as I have shown in my previous lecture, already referred to, of the 24th of October, 1889, showing how a system initiated by a patentee for Portland cement in the last century in England ended here in this country and in this city in a series of applications.

I may remark also, that here, notwithstanding to some architects the system is acceptable, the truth is that the day is very far distant when it can be given to the common use and free practices of all kinds of contractors, while they have not yet at their disposal the elements necessary, neither of material or expert hands; and for this reason the system would be dead if it was not restricted. Yes! For instance, suppose an architect, knowing and believing in the system and convinced of its utility, as to-day there are many, should project a building under this system, as insignificant as it is or appears to be; if he called for competitive estimates, in order to obtain the price, I am sure that neither the architect nor the owner would be certain that the contractor was practically able to erect the building with success in the construction. The architect, not having enough confidence in the contractor, because not knowing whether he was practical or not, and realizing that he personally is directly responsible, knows that he will be a slave of the building. On the other hand, the owner, knowing that the system was new and put in the hands of a contractor who cannot give references as to his knowledge of the matter, by his own record, will not have confidence, and would pay his money without guaranty. The contractor, too, would not be in any better position; he could not find the material nor the workmen, in the ordinary conditions that other systems would allow, and consequently all would be against either success or economy.

This is the reason that it was necessary to accumulate here, year by year, elements of security for the architects and owners, and acquire elements for the supplying the market with material and expert hands, educating able fore-

men, able masons and able helpers; of this, gentlemen, you will appreciate the cost, the great sacrifices and capital expended in order to succeed, besides the necessity of giving satisfaction to the scientific part. All of this could not be done without a guaranty; all of this had to be perfected at the commencement of the first year's work, because it is a labor of propagation and evolution. It can be seen, with these explanations, that it was necessary to protect the system, not with a desire of making a monopoly or for gain only.

In addition to that, we are introducing improvements constantly. Some of them are as follows: —

First. The custom was to use, in the first and second courses, plaster; and it was not possible to construct in any other way, thus giving an excess of plaster which was very prejudicial, as all intelligent people know, of which we gave full explanations in the lecture referred to. I pursued this method for several years, with all the annexed inconveniences, trying to discover a means of avoiding it; to-day we are using one-quarter of this plaster.

Second. Before, it frequently happened that, because of negligence in stepping or putting heavy weight on the arch before it had set, or for any other cause, the tile of the first course, having become a little separated, was likely to fall; to-day, by means of a special contrivance, the tiles can never fall, and still have the same stability.

Third. Before, the tiles were used to be covered by plaster, leaving that as a rustic form of rough material, purely constructive; to-day they are employed in a more useful way, the tiles forming the construction and decoration. That was one of the constant and noble aspirations of the art of construction; but to arrive at this point with the tile was not an easy problem, because the decorative tile is the first course, which is the most difficult to have nicely and properly jointed, when the material required for this first course gives no chance for carefully made right angles and even joints.

Fourth. In several cases it has been necessary to have flat ceilings, very light floors, practically deafened; we have to-day these conditions inside of the system.

Now, gentlemen, if the object of the law of patents is to guarantee the intellectual work, applied to new applications and improvements, is it possible to have no guaranty for all our new applications? On the other hand, I must say that more than one has had a distaste of the system as a question of nationality. Science and art have no nationality; the fact that I am not an American or am of a Southern race should not be any obstacle to the profitable progress of the art. My personality is very insignificant, and my pretensions very limited; being willing to leave at any time the way free to the man who, with surer and better talent, can carry the new ideas of construction for the common benefit of humanity, and progress of the art.

Upon the conclusion of the reading of Mr. Guastavino's paper, the chairman invited discussion of the paper, and Mr. Guastavino gave complete explanations in response to the following questions: —

A Member. I would like very much if the gentleman would illustrate on the blackboard how these tiles are put together, — whether they are laid side by side, or put flat down. I would like him further to explain how they are laid perfectly flat, instead of in the form of an arch; and what keeps the arch from spreading.

Mr. Guastavino explained these points by reference to drawings on the blackboard; and also stated that the tiles were made in different colors, — in shades of red, yellow and green; and concluded, "We have all kinds of materials, in order to vary these details and satisfy all demands for construction."

Mr. Hervey Kent. Before commencing the other paper, allow me to say a word. I have been requested to bring before the Association a matter for their consideration which

I think you will all admit is worthy of consideration. You know it has been the practice to select the Board of Government from distant parts of New England, and in some instances we have gone out of New England. They attend two regular meetings in the course of the year, and it is quite expensive; and, with the condition of our funds, allow me to make a motion, that in future the treasurer be authorized to pay the travelling expenses of the Board of Government in attending the regular and any special meetings that they may hold during the year.

The motion was seconded.

The PRESIDENT. I must say that I do not think there is any member of the Board of Government of this year that wants his travelling expenses paid; and I do not want to vote for that motion.

The Chair being in doubt, on a yea and nay vote, the motion was declared lost, upon a show of hands.

The PRESIDENT. The next paper is by Mr. W. V. WALLACE of Hinsdale, Mass., representing the Wallace Manufacturing Company, which will illustrate their system of moistening the air in mills. The paper will be read by Mr. CHARLES H. POLAND of Providence.

MOISTENING THE AIR IN MILLS.

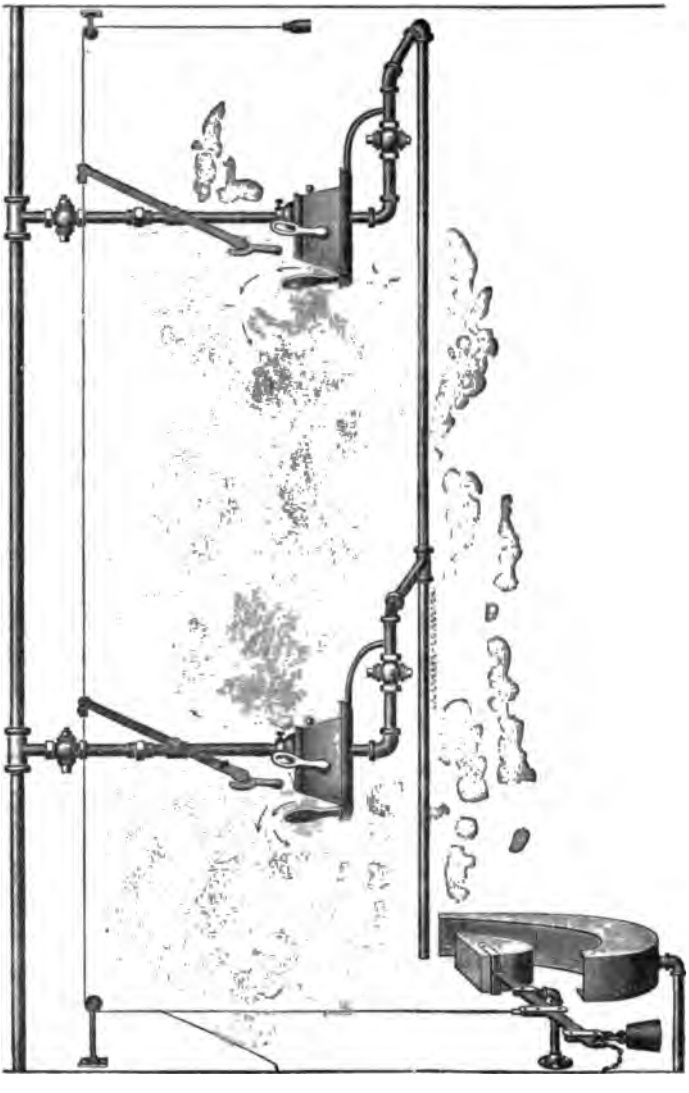
By W. V. WALLACE, Hinsdale, Mass.

To secure the most favorable conditions of the atmosphere, in respect to temperature and moisture, in rooms where textile goods are made, is a matter of great interest to the manufacturer. I accept with pleasure the invitation of your board of government to present to the association a statement of my experience in providing methods for controlling and regulating these conditions.

It was, I think, in 1882 that Professor Ordway, of the Institute of Technology, while looking at my cold-air machines, encouraged me to adapt them to textile uses. Mr. Ordway has much to answer for, as it launched me into a long line of tedious and expensive experiments, reaching from that day to this, having worked continuously these years, and tried a number of methods in different mills, with varied results.

I will say, in brief, what all well know. The processes that the cotton is put through deprive it of its natural moisture, charge it with electricity, making it unpliable and difficult to work, with loss by fly, and breaking threads, hot yarns, etc. That textiles work smooth, elastic and firm in moist air, is, I think, conceded.

The best way to produce and control the proportion of moisture is to be considered. Moisture or heat, some men say. These terms are synonymous, as warm air attracts moisture. It is apparent that the overheated, enervating workroom, closed, and perhaps charged with steam, is unnecessary, and a cruelty to the help; as in my judgment a fresh, breathable air is suited to the best results in the running of the work. A damp air cannot be artificially



THE WALLACE FOG MACHINE.

conveyed any distance, as friction rarefies it, and it is no longer damp. Therefore blasts of damp air are undesirable, having the additional objections of wetting the belts, blowing the dirt around, wetting the cards, and making it too cold and raw on a dry winter morning, when moisture is most needed.

Puffs of vapor, of ordinary water temperature, may be placed at short intervals; which is perhaps the only practicable and satisfactory method, as cold vapor does not lodge on the machinery or flooring. And this plan must be straight, simple and strong, to resist breaking belts and the famous cross-eyed boy with his broom; not obstructing the light, and well out of the way. The vapor must be fine enough to float in and be absorbed by the air; and here it is proper to say that the valves with fine grooves (as holes cannot be made small enough, and kept free) made this cold vapor in the open air possible.

These valves are adjustable, and will give more or less vapor, as the changeable atmosphere from day to day requires. In the same manner they adapt themselves to any water pressure, from twenty to two hundred pounds or more, and have the final merit of producing a fine vapor, and being easily kept free and clear. A single movement of one lever cleans a line extending the length of the room. A movement of the same lever will produce more or less vapor on the whole line. They are made of non-corrosive, bronze metal, are strong and durable. Each machine has a water-cock, and may be separately shut off. To illustrate their working capacity, in a room seventy by three hundred feet, I would recommend forty machines, which, with the plain lines of pipe, makes this the simplest and cheapest plan, at the same time producing perhaps the only satisfactory results. A piper who can attach a pipe to posts or the floor above, and pitch it so that water will run through it, can put them up. There are no tangles nor goose necks in the way of belts and brooms. There is no way by which you can wet the machinery or floor with them, and the amount of water con-

sumed is not appreciable; and they have no belts, nor expense for motive power; no oiling; and, once in line, there is practically no cost whatever in running them a period of years. One may be placed near the top of each window, which will freshen and cool the air of summer, invigorating the help and assisting the work at the same time, while this cool vapor makes the air fresh and breathable. It is not in one hundred degrees of heat proper that we suffer; it is the withdrawing of the oxygen, and its formation into floating globules, under suitable conditions, that makes the air oppressive. Natural water, mechanically vaporized, renews the oxygen, and, without materially affecting the thermometer, does, for breathing purposes, reduce the conditions of the atmosphere to a comparatively comfortable degree. Note the vicinity of a fountain and of freshly sprinkled floors or pavements. If colder air is desirable, and air motion is not harmful, four of these valves on a circular pipe two feet in diameter, with a simple pan in the centre, will produce and radiate a large quantity of cold vapor.

This device, complete and attached to the floor above, costing sixty dollars, will give double the results of any machine made for the purpose. Being open piping, it does not obstruct the light, and it is easily cleaned. I think the methods named are the most effective and least expensive that can be obtained. There is practically no wear to the machines, and they are so simply constructed and worked that they can easily be applied in lines to the floor above, or tucked in here or there, underneath other machinery.

Repeating, this cool vapor does not attach itself to polished surfaces, like steam. Some years ago, while putting into the mills large cylinder spray and fan machines (all of this species of air moisteners are crude, expensive, and consume considerable power and water to run them), I learned that mill men treated the moistening of the air as a side issue, upon which they were willing to put but little care and attention, and less expense. I have worked hard

and long to meet them on this plane, and I now offer to them a machine, the simplicity of which should have suggested itself earlier, which will moisten and keep moist five thousand cubic feet of highly heated and electrified air for ten dollars; and the cost of running this machine is the water it discharges into the air, with only a dropping of waste; and this dropping may be used again, if wished.

The difficulty has been to produce so fine a stream and keep it free, which is accomplished by the slotted valve. Any further time may better be given to an examination of the machine, which is present, and seems to be a final solution of the air-moistening problem.

The PRESIDENT. If any gentleman would like to have the machine explained, we have a model here.

Mr. POLAND. (Illustrating with model.) This machine gives an illustration in connection with this small pump, which is no part of the machine. It shows the fine vapor produced by two very fine streams of water cast upon the plate. That vapor is carried by the air and the motion of belts running, so that it finds every part of the room. The machine is operated simply by the water pressure. This is a little pump with some water here (indicating) in this pan That is not part of the machine. I have some circulars here which are prepared for circulation among the mills, and they show the method of putting them up.

A MEMBER. How much water pressure does it take?

Mr. POLAND. From sixty to eighty is the best, — any city or water pressure from a tank; a pressure of eighty pounds is preferable to sixty pounds, and they can be worked with a pump where other pressure is not obtainable. The machine is hung from the ceiling, the pipe running along the ceiling, another pipe running along here, in which this enters, carrying off the waste, which runs out through this small pipe here. There is a separate valve for each machine to let the water off, and also a waste pump to blow off whatever sediment may accumulate in the course of time; but

there is a place from this valve, which is in here, to this cock, where the water remains all the time, and, being practically stationary and not filled with water, as the streams are very fine that are thrown out through the slots, there is not much disposition to clog. In fact, there is but one mill where it has been run for any length of time, — the Orswell Mills in Fitchburg, Mass.; there they have found very little difficulty; they have had them for nearly two years. They have them connected as shown here, — connected to a line which is connected by a lever to each of the machines. The pump, as it fills with waste water, carries this lever up in this direction, so that it drops a weight attached to the end of the lever, — drops it like that (indicating), pushes it back and flushes it. That same result can be accomplished — as it is not necessary to flush them as often, perhaps, as that will do it — by having a string connected with each one, reaching down, that can be operated by hand. That, of course, costs less to put up. This can be adjusted to more or less moisture by closing or opening this little plate against which the streams strike. That can be put in a room for "aging" filling, or anything of that kind. The construction of the machine is simple; it is made well, of bronze metal.

A Member. What method do you have for taking this flushing away?

Mr. Poland. That falls into this pan, then it comes along through this little pipe; there is but little water passes down in that quick action.

The President. Does any member wish to discuss this paper?

A Member. What proportion of the water is vaporized?

Mr. Poland. I have not had enough experience with it to be able to tell you, but I think, — I know in one I have rnnning in my shop the drip falls into a common fire-pail, and is emptied not over twice a week; and this runs the twenty-four hours continually. There is a pressure of fifty-five to sixty pounds, — the water pressure of Providence; and for "aging" filling, of which I spoke, there can be a

small room set apart for that, and these vaporizers put in there. If there is moving machinery, the movement of the belts and the movement of the pulleys in the room carries the vapor. It comes up, as well as down. It is not inclined to fall in any one spot. This portion, this plate, can be set at any angle desired.

The PRESIDENT. I notice that Mr. GARLAND is present. Perhaps he can say a word.

Mr. GARLAND. I am glad that our Board of Government, realizing the importance of artificially "moistening the air in mills," have again brought this subject before the Association, and that we have had this newly gotten-up moistener exhibited and explained to us. If this apparatus shall prove to be practicable and efficient for this purpose, I hope it will meet your approval and be largely adopted in your mills.

No manufacturers of this day will deny the need and value of a moistening apparatus that will enable them to maintain a uniform humidity of sixty to eighty per cent. in every department of the mill; and to do this by atomizing water, and not by using steam, which is always objectionable.

When I was among the cotton mills of England, thirty years ago, examining processes, and picking up what information I could about manufacturing, I found that their excessively damp climate was one very favorable condition that would always enable them to make cheaper and better goods than we, unless we could artificially make a moisture in our mills; and so, returning home, I devoted all the time I could get, for more than ten years, to examining into this subject, and experimenting to invent a moistening apparatus that would artificially moisten the air; with what result most of you know, and many of you have my apparatus in your mills.

Now, while it is true that a moistened atmosphere in mills is beneficial to the health of the operatives, as well as necessary that you may produce more and better goods, it is also true that by so doing you can save one to two dollars on every bale of cotton you use; for by it you retain all of the

ten per cent. natural juice of the cotton, instead of losing three to five per cent. of this natural juice, which you now do when you have no means of moistening your mills. You can easily satisfy yourselves of the truth of this statement by experiments; first conditioning the cotton you experiment with, to determine if there is any unusual quantity of moisture in it; for we find that sometimes that is the case, though probably the water got there accidentally, of course. Now, if you will weigh the cotton that you put into your mills carefully, and also weigh all other materials that go into your goods carefully, and then weigh the product of goods and all the waste made, you will find that there is an unaccounted loss of from three to five per cent. This is the best way to find out this waste of the natural fibre; and, in fact, is the only way to fully settle the question in your own minds, and show you the necessity and value of moistened air in the mills.

All you gentlemen have found, when you have made up your semiannual accounts, doing the best you could, you have made from fifteen to twenty per cent. gross waste, and ten to fifteen per cent. net waste. To account for so large waste has been a hard task. You could always account for a part of it in sand, water, waste yarns, etc., but, doing your best, you could never account for it all,—there was three to five per cent. loss somewhere. Experience and experiment have shown that a part of the needed and useful juice of your cotton has been dried out into the air, thrown away, and you have nothing for it, only a weakened and wasted fibre. Not only this, but you have thrown away money, at the rate of one to two dollars on every bale of cotton used. If you use three million bales of cotton a year, and lose only one dollar a bale, it amounts to the large sum of three million dollars lost, which ought to be saved.

I trust you will look more carefully into this subject, and, if this or any other apparatus for moistening will do the required work and save you one dollar and more on every

bale used, that you will be ready to adopt such moistener, and apply it to your mills.

The PRESIDENT. Has any other gentleman a word to say? It has been announced that any former subjects will be in order. We expected to have another paper to present to this meeting. Mr. KLABER was expected to read a paper at this time on moistening air in mills, but he was unexpectedly called away, and perhaps some of you will feel that we are a little short of material to-day. The meeting is now open for the discussion of any former subject which members are interested in.

Mr. A. F. KNIGHT. Mr. President and gentlemen, I have something here which I have been experimenting with during the last winter. I became satisfied a few years ago that those of us who were using moisture in the atmosphere in the weaving room only, were making a mistake in not applying it to carding and spinning as well. With a carding room on the fourth floor, some years ago, I found it quite necessary to moisten the air in the carding room; deriving some benefit there, I found further benefit derived by moistening the air in the spinning room; and, during last winter, when we could use vapor steam in the carding and spinning rooms, I made a number of experiments, and found that we increased the breaking strength on our No. 50 yarn from two to four pounds. Before using this little hygrometer, I gauged the amount of moisture in the atmosphere of a room by the lengthening and shortening a rope, which I connected with a dial; but this hygrometer was finally presented to my attention, and I found it was much more sensitive, and I watched this for a while, and, as I tell you, I found I could increase the breaking strength of No. 50 yarn from two to four pounds by using the vapor more understandingly. And, let me say, vapor steam, or moisture in any form, is a very bad thing to deal with, when not used understandingly. I am satisfied we all made a mistake by using it in the weaving room only. So far as my own experiments have gone, I have derived more benefit from using the moisture around the cards and

railway heads in the carding room than around the speeder. This little thing which I have here, I understand is made in France. I am not interested in it at all, except that we have them in use in our mills; and if any of you would like to examine it, I will leave it on the desk or pass it around. You will find that it is very sensitive; just breathing on it, the moisture of the breath will be registered. In our spinning and carding rooms, fifty-five degrees is what we maintain it at; and in our weaving room, seventy-five or eighty.

Mr. GUASTAVINO. I think you are now explaining how to secure even moisture throughout a room. Is that so?

Mr. KNIGHT. Yes, sir.

Mr. GUASTAVINO. Well, now, this problem was suggested in 1869, when we built this weave room, and I will try to explain the way it was built.

The weave room was separate from the other buildings, three-quarters of its height being under ground; the ceiling was entirely of clay, and contained no wood or iron, so as to avoid rot and rust. An average depth of three feet of earth was put on the arches, in some places five feet, in order to give pitch; and over the earth, after it was well compacted, were laid three courses of tile; making a regular clay roof.

In each alternate dome was a skylight, like a truncated pyramid in form, one metre by eighty centimetres in size at the top, with ventilators on the side. The floor contained air drains, like sewers, with registers leading to the fire grates. The whole result was very satisfactory.

Mr. KNIGHT. I might have added that we have, undoubtedly, all used the wet and dry bulb thermometer, and have gone in and found the water evaporated, and the bulbs dry, and didn't know anything where we were; and before I got this little arrangement I used a cotton rope attached to the ceiling, and connected with a pointer which was moved around a dial in one direction as the rope shortened, and in the other direction as it lengthened. The rope would of course shorten as the air became moist, and lengthen as it

became dry. We kept the pointer in one position as nearly as possible by regulating the amount of vapor steam escaping into the room. We obtained quite satisfactory results with this crude arrangement, but find this hygrometer much more sensitive.

A MEMBER. I tried this little instrument we have here, and, while it is very good for showing there has been a change in the atmosphere, still I found it was not reliable; you could not tell with the wet and dry bulb thermometer how many degrees you had. We have three different mills, and with those I was unable to do it. I have an instrument which I bought at Hall's on Bromfield Street. It looks similar to a hygrometer; it indicates the degrees of humidity by a point, and it is very accurate. We have eighteen or twenty of them; they retail for twelve dollars; they are an imported instrument.

Mr. KNIGHT. This little thing was purchased of John D. Sawyer & Co. of Pawtucket, R. I. I have not tried it in comparison with the wet and dry bulb thermometer. I don't think it so important that we should know the relative humidity or the percentage of moisture in the atmosphere in a cotton mill, as that we have a standard, and keep to that standard. I became satisfied it was the best arrangement I had ever used for gauging the difference in humidity in different rooms of the mills; and I found it was a benefit to have vapor steam in the carding and spinning rooms, as well as in the weaving room. I think you will all find a benefit by using it in that way.

The CHAIRMAN. If there is no further business to come before the meeting at this time, a motion to adjourn is in order.

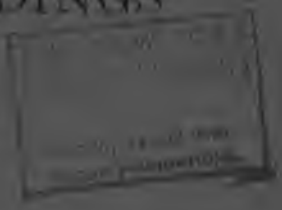
And the meeting was adjourned.

[No. 49.]

N. E. COTTON MANUFACTURERS' ASSOCIATION.

PROCEEDINGS

OF THE



SEMI-ANNUAL MEETING,

HELD AT BOSTON,

OCTOBER 29, 1890.

BOSTON:
WRIGHT & POTTER PRINTING CO.
18 POST OFFICE SQUARE.
1890.

Cotton manf.

[No. 49.]

N. E. COTTON MANUFACTURERS' ASSOCIATION.

PROCEEDINGS

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OF THE

SEMI-ANNUAL MEETING, 1896.

HELD AT BOSTON,

OCTOBER 29, 1890.

BOSTON:
WRIGHT & POTTER PRINTING CO.,
18 POST OFFICE SQUARE.
1890.

CALL FOR MEETING.

Boston, Oct. 3, 1890.

Dear Sir: — The stated semi-annual meeting of the Association will be held at the Massachusetts Institute of Technology, Boylston Street, Boston, on Wednesday, Oct. 29, 1890, at 10 o'clock A.M.

Topics heretofore discussed will still be in order if called up by any member; and, in addition, the Board have the pleasure to announce the following: —

Mr. Emile H. Klaber of Boston, Mass., will present a paper on the Manipulation of the Atmosphere in Mills, for the Purpose of charging the Same with Moisture.

Mr. F. E. Saunders of Lowell, Mass., will read a paper on the Effect upon the Cotton Fibre of Atmospheric Changes in Humidity and Temperature.

Mr. W. H. Dodge of Mishawaka, Ind., will present a paper on Rope Driving.

Mr. F. M. Messenger of North Grosvenor Dale, Conn., will give a report on a series of Tests of Spindle Oils.

Copies of these papers will be printed in advance of the meeting, and will be supplied to any member who shall apply for them to the secretary.

By order of the Board of Government,

AMBROSE EASTMAN,
Secretary.

PROCEEDINGS.

Pursuant to the foregoing notice, the regular semi-annual meeting of the Association was held at the Massachusetts Institute of Technology, Boylston Street, Boston, on Wednesday, Oct. 29, 1890, at 10 o'clock A.M.

The President, Mr. WALTER E. PARKER, occupied the chair.

The President submitted the following nominations of new members, recommended by the Board of Government, for election: —

Messrs.	STEPHEN B. ASHLEY,	Fall River, Mass.
	S. N. BROWN,	Penacook, N. H.
	CHARLES W. DENNETT,	Saccarappa, Me.
	WILLIAM F. DRAPER, Jr.,	Hopedale, Mass.
	C. S. FRISBIE,	Attawangan, Conn.
	WILLIAM C. GODFREY,	Indian Orchard, Mass.
	W. S. HUME,	Danielsonville, Conn.
	EVAN ARTHUR LEIGH,	Boston, Mass.
	G. H. SAYWARD,	Oswego, N. Y.
	JAMES P. TOLMAN,	Boston, Mass.
	H. E. WALMESLEY,	Newark, N. J.

The foregoing names were then voted upon separately, and each nominee was duly elected to membership in the Association.

The President announced that the regular programme was next in order, and accordingly called upon Mr. F. E. SAUNDERS of Lowell, who read the following paper: —

TEMPERATURE AND HUMIDITY.

ATMOSPHERIC CHANGES.

PER CENT. OF VARIATION OF WATER VAPOR, IN GRAINS. LOSS AND GAIN IN COTTON FIBRE.

By F. E. SAUNDERS, Lowell, Mass.

One of the problems that our manufacturers are trying to solve is that of atmospheric changes, their effect upon cotton fibres, and the best methods to adopt in our mills in order to control them. It is safe to say that it is a very difficult question to solve, from the fact that it is of such a complex nature. For instance, the temperature and humidity in our mills may be at one point, and in a few hours a change in the weather has resulted in adding to or taking from the moisture in the atmosphere. In presenting a paper before the Manufacturers' Association, it is for the purpose of treating the subject in a practical manner, so that we may better understand how to regulate our work, when these changes take place. When a physician is called to treat a difficult disease, he at once takes a diagnosis of the case, and then applies the remedy. In the subject before us, quite a number have taken careful observations of these atmospheric changes that are constantly occurring, and yet are at a loss where to apply the remedy. The time may come when we shall be able to control these changes so far as to, in a measure, eliminate the effects of electricity.

Moisture of the Atmosphere.

It may be of general interest at this time to give the temperatures and humidities of the several localities of Europe and America. The absolute moisture of the atmosphere varies with the temperature, both in the course of the year and of the day. In summer there is a maximum at 8 in the morning and evening, and a minimum at 3 P.M. and 3 A.M., because the ascending current of air carries the moisture upwards. The absolute is greatest in the tropics, where it represents a pressure of 25 ^{mm}; while in our latitude it does not exceed 10 ^{mm}. The relative moisture, on the other hand, is at a minimum in the hottest, and at its maximum in the coolest, part of the day. It varies also in different regions. It is greater in the centre of continents than it is on the sea or the sea-coast. That the dryness diminishes with the distance from the sea, is shown by the clearer atmosphere of continental regions. In Platowskya, Siberia, the air at a temperature of 24° was found to contain a quantity of moisture only sufficient to saturate at 3°. The air might, therefore, have been cooled through 27° without any deposit of moisture. In some parts of East Africa the springs of powder flasks exposed to the damp atmosphere snap like twisted quills; paper becomes soft and sloppy, by the loss of glaze; and gunpowder, if not kept hermetically sealed, refuses to ignite. On the other hand, in North America, where the west and north-west winds blow over large tracts of land, the moisture in the air is less than in Europe. Evaporation is, therefore, more rapid than in Europe; clothes dry quickly, bread soon becomes hard, newly built houses can be at once occupied. European pianos soon give way there, while American-built pianos are very durable on this side of the ocean. Evaporation is quicker, the drier the air, as will be observed by consulting the hygrodeik readings of the several mills.

Direction of Winds.

It is a well-known fact that the temperature and absolute humidity is much evener in Lancashire, England, than in New

England. The difference between the average July and the average January temperatures seems to be in Lancashire only 18°, which, compared with the apparent difference of 45° in Massachusetts, is small. There is found in Lancashire a set of conditions of temperature, prevailing winds and geographical surroundings, which is hard to believe can be duplicated. The most frequent wind is that from the south-west, and this, blowing from off the Gulf Stream, is naturally full of moisture. The relative and absolute humidities run even, as compared to New England, as will be seen from the following table of temperature readings observed in Stalybridge, England, for the month of July, 1887: —

Temperature, Stalybridge, England.

1887.						Winds.
July 1, .	70	65	61	71	5.942	South-west.
2, .	67	65	64	90	6.564	North-west.
3, .	70	66	64	81	6.564	South-west.
4, .	68	64	62	81	6.143	North-west.
5, .	59	55	52	78	4.373	North-west.
6, .	60	56	53	78	4.527	South-west.
7, .	64	63	62	95	6.143	South-west.
8, .	76	67	66	70	7.010	South-west.
9, .	67	63	61	80	5.942	South-west.
10, .	61	59	58	89	5.371	North-west.
11, .	62	61	60	95	5.746	South-west.
12, .	67	64	62	85	6.143	South-west.
13, .	69	65	63	81	6.350	South-west.
14, .	64	61	59	85	5.526	South-west.
15, .	64	60	57	79	5.192	South-west.
16, .	60	57	55	84	4.850	North-west.
17, .	56	54	53	88	4.527	North-east.
18, .	59	56	54	83	4.686	South-west.
19, .	60	60	60	100	5.746	North-west.
20, .	64	63	62	95	6.143	North-west.

Temperature, Stalybridge, England — Concluded.

1887.						Winds.
July 21, .	58	58	58	100	5.371	South-west.
22, .	66	63	61	85	5.942	South-west.
23, .	62	57	53	74	4.527	North-west.
24, .	65	63	62	90	6.143	South-west.
25, .	60	58	57	89	5.192	South-west.
26, .	65	60	57	75	5.192	South-west.
27, .	63	61	60	89	5.746	South-west.
28, .	62	61	60	95	5.746	South-west.
29, .	65	63	62	90	6.143	South-west.
30, .	60	63	55	84	4.850	South-west.
31, .	59	53	54	83	4.686	South-west.

Water Vapor: Maximum, 7.010 grains; minimum, 4.373 grains; mean, 5.581 grains. Prevailing south-west winds.

It can very readily be seen from this table why there is such a uniformity of moisture and relative humidity. We find that in this month the wind blew from the south-west twenty-two days. In order to fully cover the point under discussion, I will present the following table, showing the number of days in one thousand that the wind blows from each of the eight points of the compass in Lancashire: —

Direction, . .	N.,	NE.,	E.,	SE.,	S.,	SW.,	W.,	NW.
Days, . . .	82,	111,	99,	81,	111,	225,	171,	120.

I will also present the following table, showing the number of days in nine hundred and sixty-five that the wind blew from each of the eight points of the compass in New England: —

Direction, . .	N.,	NE.,	E.,	SE.,	S.,	SW.,	W.,	NW.
Days, . . .	91,	70,	62,	60,	105,	150,	200,	225.

It will be seen from these tables that the prevailing winds of England are south-west and west, while the prevailing winds of

New England are west and north-west; coming from a non-humidity-producing region. This certainly has a very important bearing upon the great manufacturing centres of New England; as well as the fact that our temperatures and humidities are constantly fluctuating.

Hygrodeik Readings.

Wishing to compare temperature readings in different mills at the same time, I have been very kindly assisted by Messrs. Walter E. Parker of the Pacific, E. W. Thomas of the Tremont and Suffolk, and J. W. Kent of the Wamsutta. These readings were carefully observed at the same hour of the day, except the Wamsutta, where the time of observation was a little later. The amount of absolute humidity has been worked out from signal-service tables, so that we can see at a glance what a cubic foot of air contains. The maximum, minimum and mean of each mill has also been worked out, so that we can see the loss and gain sustained.

We find from these temperature readings that the loss and gain of water vapor in the atmosphere was as follows: Pacific, 67.76 per cent.; Wamsutta, 47.88 per cent.; Suffolk, 48.17 per cent.; Tremont, 53.43 per cent.; Hamilton, 51.62 per cent. This certainly seems to be a very large per cent., but we must take into consideration the fact that the atmospheric changes were very marked. Take, for instance, July 8 in the Hamilton Mills. At the reading 2 P.M., the thermometers indicated 9.067 grains per cubic foot of air, and at 2 P.M., July 10, 4.527 grains, or a loss of nearly 50 per cent. of moisture. We will at this time make an estimate of the loss and gain of water vapor in the Tremont Mills. The highest point reached 9.067 grains: now, if we multiply the number of grains by the cubic feet of air (which we will call 300,000), and divide by 7.000 (the number of grains in a pound), we shall obtain 388 pounds of water. If we desire to carry this into gallons, we first ascertain what a gallon of water will weigh, which is 8.322 pounds. Now, if we divide 388 by 8.322, we shall get a product of 46 gallons of water contained in the room.

Again, we find that the lowest point reached was 4.223 grains per cubic foot. Now, if we multiply 4.223 by 300,000, and divide by 7.000, we shall get a product of 180 pounds of water. This 180, divided by 8.223, gives us 21 gallons of water.

Temperature and Humidity.

There are a good many mill men who are interested in the subject of temperature and humidity, who have not made a study of it sufficient to fully understand how to work out a problem and ascertain the relative humidity and amount of water vapor in a cubic foot of air. We often hear people speak of the temperature, but seldom of the relative humidity and dew-point. The dew-point is that temperature at which the air would become saturated when cooled, if no water were added to or taken from it. One way in which the relative humidity of the air is determined is to first find the dew-point of the air, and then by a simple division obtain the relative humidity. In order to ascertain the amount of water vapor in a cubic foot, and the per cent. of relative humidity in the air, a dry and wet bulb thermometer or hygrodeik is used. One bulb is covered with a wick or muslin, which connects it with a glass or cup full of rain or distilled water; the other bulb is left dry, and free to the air. I have found in my observations that the best position to place the instrument is some six feet from the floor, in the centre of the room. In order to work out the dew-point and humidity of the air, I will reproduce two valuable tables. The first is that of weights of saturated steam, compiled by Charles F. Porter. The second is the dew-point and relative humidity table, compiled by the Signal Service, Washington, D. C. Scientists have concluded that the weight of water which a cubic foot of atmosphere can contain, and which it does contain when it is saturated, is the weight of a cubic foot of saturated steam of the temperature of that atmosphere; so that, if we know that the air is saturated, we can immediately know the weight of water in a cubic foot, by looking into one of the tables of the weight of water in a cubic foot of such steam at a temperature of the atmosphere.

Hygrodeik Readings.

	Wet.	Dew Point.	Relative Humidity.	Water Vapor, in Grains.
	74	73	61	8.784
	78	72	49	8.509
	68	58	39	5.371
	68	57	35	5.192
	62	51	39	4.223
	64	53	38	4.527
	65	56	44	5.018
	68	59	44	5.526
	68	59	44	5.526
	–	–	–	–
	69	63	57	6.350
	68	59	44	5.526
	74	69	57	7.728
	77	71	48	8.241
	76	70	52	7.981
	72	61	34	5.942
	76	70	50	7.981
	74	65	29	6.784
	66	58	47	5.371
	66	57	42	5.192
	65	56	44	5.018
	–	–	–	–
	69	64	60	6.564
	70	65	58	6.784
	67	60	51	5.746
	66	58	47	5.371
	67	59	45	5.526
	68	61	48	5.942
	67	59	48	5.526
	69	64	60	6.564
	72	68	62	7.482
	76	71	58	8.241
	78	74	64	9.067
	–	–	–	–
	73	67	54	7.243
	72	64	44	6.564
	72	66	51	7.010
	74	69	57	7.728
	78	74	64	9.067
	76	69	48	7.728
	78	73	54	8.784
	78	71	47	8.241
	78	74	59	9.067
7	72	66	53	7.010
4	72	66	51	7.010
5	–	–	–	–
–	76	71	58	8.241
6	78	74	59	9.067
9	77	72	53	8.509
7	78	72	49	8.509
79	77	68	38	7.482
75	76	70	52	7.981
75	68	59	44	5.526
72	68	59	44	5.526
68	70	64	55	6.564
74	73	65	53	6.784
69	70	65	61	6.784
75	–	–	–	–

foot: Maximum, 9.067; minimum,

axi

Point.	Relative Humidity.	Water Vapor, in Grains.
2	60	8.509
4	64	9.067
2	45	6.143
8	52	7.482
2	45	6.143
2	45	6.143
7	56	7.243
2	54	6.143
7	59	7.243
–	–	–
8	62	7.482
0	63	7.981
3	69	8.784
4	64	9.358
4	64	9.067
3	54	8.784
4	61	9.067
4	64	9.067
9	57	7.728
3	49	6.350
8	62	7.482
–	–	–
9	50	5.526
2	54	6.143
4	55	6.564
4	52	6.564
–	–	–
–	–	–
6	64	7.010
7	68	7.243
6	77	9.657
4	67	9.067
4	67	9.067
–	–	–
5	70	9.358
1	58	8.241
7	65	9.964
6	62	9.657
4	64	9.067
4	59	9.067
4	64	9.067
7	65	9.964
7	65	9.964
4	64	9.067
5	70	9.358
–	–	–
6	73	9.657
9	71	10.603
7	71	9.964
9	71	10.603
5	70	9.358
5	70	9.358
2	60	8.509
8	52	7.482
4	64	9.067
9	57	7.728
5	[illegible]	9.358
		–

imum,

1890.	Hour.	Dry.	Wet.
July 8,	7 A.M.	85	77
	2 P.M.	90	78
9,	7 A.M.	84	70
	2 P.M.	88	70
10,	7 A.M.	79	65
	2 P.M.	78	64
11,	7 A.M.	77	66
	2 P.M.	76	68
12,	7 A.M.	80	68
	–	–	–
14,	7 A.M.	77	68
	2 P.M.	82	69
15,	7 A.M.	80	73
	2 P.M.	88	78
16,	7 A.M.	86	76
	2 P.M.	90	78
17,	7 A.M.	86	74
	2 P.M.	88	75
18,	7 A.M.	82	70
	2 P.M.	82	66
19,	7 A.M.	76	66
	–	–	–
21,	7 A.M.	77	66
	2 P.M.	78	64
22,	7 A.M.	77	64
	2 P.M.	80	76
23,	7 A.M.	80	68
	2 P.M.	79	65
24,	7 A.M.	79	70
	2 P.M.	79	69
25,	7 A.M.	81	73
	2 P.M.	85	78
26,	7 A.M.	84	77
	–	–	–
28,	7 A.M.	83	76
	2 P.M.	83	73
29,	7 A.M.	85	76
	2 P.M.	87	75
30,	7 A.M.	81	72
	2 P.M.	84	72
31,	7 A.M.	84	76
	2 P.M.	92	79
Aug. 1,	7 A.M.	86	78
	2 P.M.	82	71
2,	7 A.M.	84	74
	–	–	–
4,	7 A.M.	82	77
	2 P.M.	89	77
5,	7 A.M.	82	77
	2 P.M.	89	77
6,	7 A.M.	82	77
	2 P.M.	87	76
7,	7 A.M.	84	72
	2 P.M.	84	72
8,	7 A.M.	82	72
	2 P.M.	84	72
9,	7 A.M.	82	74
	–	–	–

Water vapor, in grains, per cubic foot: 4.850; mean, 7.425.

K READINGS.

int.	Relative Humidity.	Water Vapor, in Grains.
	70	9.067
	59	9.067
	49	6.350
	40	5.942
	47	5.192
	46	4.850
	56	5.746
	66	6.564
	54	6.143
	–	–
	63	6.350
	52	6.143
	72	7.981
	64	9.067
	63	8.509
	59	9.067
	57	7.728
	49	7.010
	55	6.564
	42	5.192
	59	5.942
	–	–
	56	5.746
	46	4.850
	49	5.018
	83	9.067
	54	6.143
	47	5.192
	64	7.010
	60	6.564
	68	7.981
	73	9.358
	73	9.067
	–	–
	66	7.981
	62	7.728
	66	8.509
	57	7.981
	65	7.482
	56	7.243
	69	8.784
	56	9.067
	70	9.358
	58	7.010
	63	7.981
	–	–
	80	9.358
	58	8.509
	80	9.358
	58	8.509
	80	9.358
	60	8.509
	56	7.243
	56	7.243
	62	7.482
	56	7.243
	69	8.241
	–	–

mum, 9.358; minimum,

TREMONT MILLS: HYGRODEIK READINGS.

1890.	Hour.	Dry.	Wet.	Dew Point.	Relative Humidity.
July 8,	7 A.M.	88	74	73	61
	2 P.M.	94	78	72	49
9,	7 A.M.	86	68	58	39
	2 P.M.	88	68	57	35
10,	7 A.M.	78	62	51	39
	2 P.M.	81	64	53	38
11,	7 A.M.	80	65	56	44
	2 P.M.	84	68	59	44
12,	7 A.M.	84	68	59	44
	–	–	–	–	–
14,	7 A.M.	80	69	63	57
	2 P.M.	84	68	59	44
15,	7 A.M.	86	74	69	57
	2 P.M.	93	77	71	48
16,	7 A.M.	90	76	70	52
	2 P.M.	94	72	61	34
17,	7 A.M.	91	76	70	50
	2 P.M.	94	74	65	29
18,	7 A.M.	80	66	58	47
	2 P.M.	82	66	57	42
19,	7 A.M.	80	65	56	44
	–	–	–	–	–
21,	7 A.M.	79	69	64	60
	2 P.M.	81	70	65	58
22,	7 A.M.	80	67	60	51
	2 P.M.	80	66	58	47
23,	7 A.M.	82	67	59	45
	2 P.M.	82	68	61	48
24,	7 A.M.	81	67	59	48
	2 P.M.	79	69	64	60
25,	7 A.M.	82	72	68	62
	2 P.M.	88	76	71	58
26,	7 A.M.	88	78	74	64
	–	–	–	–	–
28,	7 A.M.	86	73	67	54
	2 P.M.	89	72	64	44
29,	7 A.M.	86	72	66	51
	2 P.M.	86	74	69	57
30,	7 A.M.	88	78	74	64
	2 P.M.	92	76	69	48
31,	7 A.M.	92	78	73	54
	2 P.M.	95	78	71	47
Aug. 1,	7 A.M.	90	78	74	59
	2 P.M.	85	72	66	53
2,	7 A.M.	86	72	66	51
	–	–	–	–	–
4,	7 A.M.	88	76	71	58
	2 P.M.	90	78	74	59
5,	7 A.M.	91	77	72	53
	2 P.M.	94	78	72	49
6,	7 A.M.	98	77	68	38
	2 P.M.	90	76	70	52
7,	7 A.M.	84	68	59	44
	2 P.M.	84	68	59	44
8,	7 A.M.	82	70	64	55
	2 P.M.	84	73	65	53
9,	7 A.M.	80	70	65	61
	–	–	–	–	–

Water vapor, in grains per cubic foot: Maximum, 9.0
4.223; mean, 6.957

HYGRODEIK

Dew Point.	Re Hu	Wet.	Dew Point.	Relative Humidity.	Water Vapor, in Grains.
		74	73	61	8.784
72		78	72	49	8.509
74		68	58	39	5.371
62		68	57	35	5.192
68		62	51	39	4.223
62		64	53	38	4.527
62		65	56	44	5.018
67		68	59	44	5.526
62		68	59	44	5.526
67		–	–	–	–
–		69	63	57	6.350
68		68	59	44	5.526
70		74	69	57	7.728
73		77	71	48	8.241
74		76	70	52	7.981
74		72	61	34	5.942
73		76	70	50	7.981
74		74	65	29	6.784
74		66	58	47	5.371
69		66	57	42	5.192
63		65	56	44	5.018
68		–	–	–	–
–		69	64	60	6.564
59		70	65	58	6.784
62		67	60	51	5.746
64		66	58	47	5.371
64		67	59	45	5.526
–		68	61	48	5.942
–		67	59	48	5.526
66		69	64	60	6.564
67		72	68	62	7.482
76		76	71	58	8.241
74		78	74	64	9.067
74		–	–	–	–
–		73	67	54	7.243
75		72	64	44	6.564
71		72	66	51	7.010
77		74	69	57	7.728
76		78	74	64	9.067
74		76	69	48	7.728
74		78	73	54	8.784
74		78	71	47	8.241
77		78	74	59	9.067
77		72	66	53	7.010
74		72	66	51	7.010
75		–	–	–	–
–		76	71	58	8.241
76		78	74	59	9.067
79		77	72	53	8.509
77		78	72	49	8.509
79		77	68	38	7.482
75		76	70	52	7.981
75		68	59	44	5.526
72		68	59	44	5.526
68		70	64	55	6.564
74		73	65	53	6.784
69		70	65	61	6.784
75		–	–	–	–
–					

e foot: Maximum, 9.067; minimum,

: Maxin

Tables of Saturated Steam.

Weight in pounds of 1,000 cubic feet of saturated steam, or the weight in pounds of water vapor in 1,000 feet of saturated atmosphere, at a temperature from 32° up to 121°.

Temperature.	Pounds.	Temperature.	Pounds.	Temperature.	Pounds.	Temperature.	Pounds.	Temperature.	Pounds.	Temperature.	Pounds.
32	.30	47	.52	62	.88	77	1.43	92	2.26	107	3.50
33	.30	48	.54	63	.91	78	1.48	93	2.33	108	3.60
34	.31	49	.56	64	.94	79	1.53	94	2.40	109	3.70
35	.32	50	.58	65	.97	80	1.58	95	2.47	110	3.80
36	.33	51	.60	66	1.00	81	1.63	96	2.54	111	3.90
37	.34	52	.62	67	1.03	82	1.68	97	2.62	112	4.00
38	.36	53	.65	68	1.07	83	1.73	98	2.70	113	4.10
39	.38	54	.67	69	1.11	84	1.78	99	2.78	114	4.21
40	.40	55	.69	70	1.15	85	1.83	100	2.86	115	4.33
41	.42	56	.71	71	1.19	86	1.89	101	2.94	116	4.45
42	.43	57	.73	72	1.23	87	1.95	102	3.02	117	4.57
43	.45	58	.76	73	1.27	88	2.01	103	3.11	118	4.70
44	.47	59	.79	74	1.31	89	2.07	104	3.20	119	4.83
45	.49	60	.82	75	1.35	90	2.13	105	3.30	120	4.96
46	.50	61	.85	76	1.39	91	2.19	106	3.40	121	5.08

Dew-Point and Relative Humidity.

	Dew Point.	Relative Humidity.	Dew Point.	Relative Humidity.	Dew Point.	Relative Humidity.	Dew Point.	Relative Humidity.	Dew Point.	Relative Humidity.	Dew Point.	Relative Humidity.	Dew Point.	Relative Humidity.	Dew Point.	Relative Humidity.	Dew Point.	Relative Humidity.
	6		7		8		9		10		11		12		13		14	
70	60	72	59	68	57	64	55	60	53	55	51	52	49	48	47	44	45	40
71	62	72	60	68	58	64	56	60	55	56	53	52	51	48	48	45	46	41
72	63	73	61	69	59	65	58	61	56	57	54	53	52	49	50	45	47	42
73	64	73	62	69	61	65	59	61	57	57	55	53	53	50	51	46	49	42
74	65	74	63	70	62	66	60	62	58	58	56	54	54	50	52	47	50	43
75	66	74	64	70	63	66	61	62	59	58	57	55	56	51	54	47	52	44
76	67	74	66	70	64	66	62	63	61	59	59	55	57	52	55	48	53	45
77	68	74	67	71	65	67	63	63	62	59	60	56	58	52	56	49	54	45
78	69	75	68	71	66	67	65	63	63	60	61	56	59	53	57	49	55	46
79	70	75	69	71	67	68	66	64	64	60	62	57	61	53	59	50	57	47
80	72	75	70	72	68	68	67	64	65	61	63	57	62	54	60	51	58	47
81	73	76	71	72	70	68	68	65	66	61	65	58	63	54	61	51	59	48
82	74	76	72	72	71	69	69	65	68	62	66	58	64	55	62	52	61	48
83	75	76	73	73	72	69	70	66	69	62	67	59	67	56	64	52	62	49
84	76	77	74	73	73	69	71	66	70	63	68	59	67	56	65	53	63	49
85	77	77	75	73	74	70	72	66	71	63	69	60	68	56	66	53	64	50
86	78	77	76	73	75	70	73	67	72	63	71	60	69	57	67	54	66	51
87	79	77	78	74	76	70	74	67	73	64	72	60	70	57	68	54	67	51
88	80	77	79	74	77	71	75	67	74	64	73	61	71	58	70	55	68	52
89	81	78	80	74	78	71	76	68	76	64	74	61	72	58	71	55	69	52
90	82	78	81	75	79	71	78	68	77	65	75	62	74	59	72	56	70	53

This dew-point and relative humidity table is calculated from a barometric pressure of thirty inches. I have arranged this table for a difference of 8°, running from 6° up to 14° between the wet and dry bulbs, and in temperature from 70° up to 90°. By the use of these tables we can by a little study read the temperatures and work out the amount of water vapor in the atmosphere very readily. Suppose I go to my thermometer, and it stands at 76, 66. Now, by consulting the dew-point table, I find, in the column marked 10, 61, 59. Then the reading would be 76 dry, 66 wet, 61 dew-point and 59 relative humidity. I find by this that the atmosphere is moistened a little more than one-half it is capable of containing. Now, by looking at the table of saturated steam, we see that at 76° temperature the air is capable of holding 1.39 pounds of water in each 1,000 cubic feet of air; but, as it is only 59 per cent. saturated, we see at once that the air contains only 0.85 pound; in other words, if we consult our dew-point and humidity table, we shall find that a relative humidity of 59 gives a dew-point of 61. Now, by looking at the table of saturated steam, we find, opposite a temperature of 61°, 0.85 pounds. So, if we multiply this by 7.000 (the number of grains in a pound), and divide by 1,000 (the number of cubic feet used as a basis), it will give us the number of grains contained in one cubic foot of air, — $0.85 \times 7.000 = 5.950 \div 1.000 = 5.950$ grains water vapor. To ascertain the relative humidity from the tables: the weight of 1,000 feet of saturated steam at 61° is 0.85 pound, and at 76° it is 1.39 pounds; now, if we divide 85 by 139, we ascertain the per cent. of relative humidity in the air.

Dew-Point and Absolute Humidity, in Grains.

Dew-Point.	0	1	2	3	4	5	6	7	8	9
10	.873	.911	.950	.991	1.033	1.077	1.122	1.169	1.218	1.268
20	1.320	1.374	1.431	1.489	1.549	1.611	1.676	1.743	1.812	1.883
30	1.957	2.034	2.113	2.195	2.280	2.367	2.457	2.550	2.646	2.746
40	2.849	2.955	3.065	3.178	3.295	3.415	3.539	3.668	3.801	3.937
50	4.077	4.223	4.373	4.527	4.686	4.850	5.018	5.192	5.371	5.526
60	5.746	5.942	6.143	6.350	6.564	6.784	7.010	7.243	7.483	7.728
70	7.981	8.241	8.509	8.784	9.067	9.358	9.657	9.964	10.279	10.603
80	10.936	11.278	11.628	11.988	12.358	12.737	13.127	13.529	13.941	14.362
90	14.794	15.238	15.693	16.160	16.637	17.128	17.631	18.146	18.674	19.216
100	19.771	20.340	20.922	21.518	22.129	22.756	23.397	24.053	24.725	25.413

By the use of this table anyone can ascertain at a glance what amount of vapor there is in the air. For instance, suppose the dew-point is 66: just run the eye from 60 out to column marked 6, and we find 7.010 grains.

Atmospheric Changes.

Atmospheric changes in the mills are frequently of great injury to the work; especially is this the case in the carding department. Let me give one illustration, as an evidence of the truth of the statement made. On June 18, 2 P.M., the temperature was 88 dry, 76 wet, 71 dew-point, 58 relative humidity, with 8,241 grains of water vapor in a cubic foot of air; atmosphere very close and sticky. The weight of work at railway heads run 2.2 per cent. on heavy side. Weight of sample near the hygrodeik, 1.4 per cent. on heavy side. Wind, south-west, clear. On June 19, 8 A.M., the temperature was 84 dry, 72 wet, 67 dew-point, 56 relative humidity, with 7,243 grains of water vapor in a cubic foot of air, with a bracing north-west wind. The weight of work at railway heads

dropped in weight from 2.2 on the heavy side down to 3.7 per cent. on the light side, with a loss in weight of sample of 1.4 per cent. We find, from this slight change of only 3° of dew-point, that the weight of the work at the railways has varied 5.9 per cent.; while the loss of moisture in sample was 1.4 per cent., and a loss in absolute humidity of .998 grains. Again, on July 8, 6 P.M., wind south-west, fair temperature, 95 dry, 80 wet, 75 dew-point, 52 relative humidity, with 9.358 grains water vapor in cubic foot of air, weight of sample, 135.5 grains. On July 9, 6 P.M., wind north-west, clear temperature, 84 dry, 66 wet, 53 dew-point, 34 relative humidity, with 4.527 grains of water vapor in cubic foot of air, weight of sample, 133.5 grains. Loss in water vapor, 51 per cent.; loss in sample, 1.4 per cent., and variation at railway heads of 8 per cent.

In presenting the result of these atmospheric changes, it is for the purpose of showing how essential it is for the welfare of the spinning and weaving that the carders keep a firm hold upon their work, so far as keeping numbers is concerned. There are two influences brought to bear upon cotton fibres during their processes of manufacturing through the card room. One is a damp atmosphere, and another is a dry atmosphere. These have to be guarded against by the carders, in order that the spinners and weavers may not feel the effects of them. When a damp spell of weather comes on, the tendency is to let the yarn become too heavy, not because there is moisture sufficient to make it heavy, but by reason of more cotton fibres per inch of yarn spun. On the other hand, when the atmosphere becomes divested of moisture, the work at the railway heads will shade light unless watched pretty closely, and the result will be light yarn, by reason of loss of cotton fibres. Now, as a result of this there is a loss to the manufacturer in two ways. First, if the yarn is spun and warped heavy, th cloth will grade on the heavy side of standard. This entail loss to the manufacturer, from the fact that more cotton the yarn than ought to be. Second, if the yarn is spu dressed light, the weaving will also be light. There ir

in the product from this state of things, as well as an increased per cent. of low-grade cloth.

I find quite a general feeling among mill men pointing in one direction, and that is this. They convey the idea in their remarks that the variations of loss and gain in yarns are due to the changes of weather in that the damp air goes in and comes out, thus leaving the yarn first heavy, then light. This theory in the abstract is correct, but not as a whole. I find in my daily weighings for some four or five years that the loss and gain in samples of cotton would not exceed four per cent., and in very much of the time the variations would not exceed two per cent. I find from this condition of things that it won't do to run our work as close as this during atmospheric changes. We must make allowance for the extra loss and gain that comes with these atmospheric changes.

In closing this paper, I wish to say that I am of the opinion that very much of the uneven yarn that is spun in our mills is caused by too much indifference in the carding departments in regard to the changes of weather, and the effect they have upon the work. If we expect to get uniform yarns, we must pay strict attention to our numbers in the card rooms. It is the poorest kind of policy to say the work will be all right when the weather changes. Better by all odds see to it that the work is all right before the weather changes, and not only that, but see to it that it is all right after the weather changes. With this care in the carding rooms there will be no necessity of poor spinning or weaving. Of course the very best care may be exercised, and then poor work get in; but, as a general thing, the spinning and weaving will run well.

The PRESIDENT. Mr. SAUNDERS has suggested the evils of atmospheric changes. Mr. BOURNE of Manchester, N. H., will tell you you must go back to the picker-room to remedy those evils, and perhaps will tell you what he has done to remove them. Mr. KLABER will tell you how his theory is put in practice. I have the pleasure of presenting Mr. KLABER.

MANIPULATION OF THE ATMOSPHERE IN MILLS FOR THE PURPOSE OF CHARGING THE SAME WITH MOISTURE, SUCH MOISTURE BEING DISCHARGED WITH LARGE BODIES OF AIR, AND CAPABLE OF REGULATION BOTH AS TO QUANTITY OF AIR AND MOISTURE.

By Emile H. Klaber, Boston, Mass.

In presenting a paper to this Association upon the subject of moistening the air in mills, I feel placed at a certain disadvantage, inasmuch as, while endeavoring to lay the facts connected with this matter before you in an unprejudiced and general manner, the fact that I am myself interested in such a system may tend to color my discussion of the subject with a prejudice which I do not desire it to possess.

In reviewing the various theories that are advanced and the conditions which are met and have to be grappled with in attempting to properly solve this problem, I may have occasion to refer to devices that have been used in respect to the subject matter of this paper. I desire emphatically to state at the outset that my criticism of any such devices is not intended to apply to the specific device in question, but to the general principles involved in the construction thereof.

I furthermore wish my opinion to go on record that moisture in certain parts, and at certain times in all parts, of a mill, is such an essential factor to successful work that I regard any device having such object for its aim as a step in the right direction. On this question I think I may assume that all rational manufacturers are agreed. I consider it would be

superfluous, and a presumption on my part, to attempt to lay before you the advantages to be derived from an equable degree of humidity and temperature in a factory. It may also be superfluous for me to state here the advantages of vaporized water, as compared with steam. The cost of the latter, the rotting of the floors and general damage to buildings, and the serious effect of steam upon the health of the help, is beyond all dispute.

In Germany, where the government protects the health of its people, and more particularly the laborers and mechanics which form its army, the use of steam in factories is forbidden, it having been proved by the authorities that it is hurtful to the health of those under its influence.

In these times of enlightenment, when the continents of Europe and America are so in touch with one another that facts occurring on one side are matters of simultaneous knowledge on the other, it will be unnecessary to tell you that there is scarcely a mill in Europe where some device is not employed for producing humidity of the atmosphere.

Vaporized water is gradually but surely superseding steam, and that it has not entirely done so to-day is attributable to the fact that hitherto no satisfactory system, with the advantages admittably to be derived from water, but embodying the simplicity with which steam can be used, has been put before manufacturers. Various devices have been manufactured and marketed, and have enjoyed a certain amount of prosperity; but it has been in the nature of their construction and principle to fail in the two most essential conditions for success, — simplicity and reliability.

Let us now consider and analyze the ways by which water may be formed into vapor, and the ways by which it may then afterward be distributed into the atmosphere. Such methods are not many, and may prove interesting subjects for consideration.

Let us first take the old atomizer. This system of dividing fluids into minute sprays was discovered by a Frenchman, and applied to the use of distributing drugs, in the form of fine

spray, for medicinal purposes. A flexible bulb was used for the purpose of producing a result by which water and air were expelled together, the latter under a high pressure atomizing the fluid, which emanated from a very small aperture, and was met at the mouth by the force of the air. I believe credit is due to Mr. Garland for being the first to construct a system whereby, with the assistance of a high-pressure air pump, a number of such atomizing devices could be set in operation from one main source of power.

Another method of producing water vapor is by the impingement of a fine jet of water against a suitable impinging surface, the water being impelled against such impinging surface with sufficient force to cause it to be broken up into minute particles.

Oehlmann, a German, was the first to attempt to adapt this principle for use in factories; and, although his success was only partial, he subsequently, by an attachment which he connected with such device, laid the foundation of a practical and successful system. The attachment in question was a device for inducing an air current, and distributing into the room therewith the spray or moisture he had produced by impingement. The difficulties encountered in perfecting this invention may be judged from the fact that, although some thirteen years have elapsed since the conception of this invention, improvements and modifications have from time to time been found desirable, in fact, in some instances, imperative.

Notwithstanding these facts, some totally inexperienced theorists have considered the moistening of mills a solved problem, by producing a small amount of water spray, allowing it to fall on the machinery or floor thereunder, and leaving out of consideration the fact that it is the atmosphere that has to be. manipulated and moistened, and not the floors and machinery. The impracticability of, and the damage caused by, such crude devices, are too well known to need recapitulation here. The wetting of the floors and machinery, the clogging up of the water outlets, the cost of fitting, the work required

to keep them in order, and, above all, the non-practicability of regulating all such devices, are matters of general knowledge.

I could say much more upon the defects inherent to any system which provides moisture without any means of properly distributing or regulating the same; but my object here is not to criticise specific devices, but to lay before you an apparatus which embodies the principles I advocate, and which is simple in construction, reliable in operation, and of practical value for doing that which is required.

I wish, without prejudice, to point out to you the merits and advantages of a device constructed on the principles before mentioned; and, whether it be the Aerophor (which apparatus I shall have the honor of explaining to you presently), or some other apparatus which, while not infringing the patents granted upon the Aerophor, embodies the same or similar principles, I feel confident that such is the only practical and effectual means of giving the manufacturer proper humidity of the atmosphere, and in the manner he needs it.

The Aerophor, gentlemen, has been on the market in Europe for the last eight years; and the amount of business done, and those willing and prepared to endorse this system, have increased from year to year. I do not desire that this statement should carry any weight with the American manufacturer, by reason of this statement taken alone; but, when the fact is considered that the German manufacturer is as a rule a self-made man, careful and conservative to a degree, and that he must thoroughly see the advantages of an investment before he will identify himself with it, I consider this statement, then, the strongest possible endorsement of the value of such a device, not necessarily of the Aerophor, but of any device which will effectually produce moisture and distribute it in the that the Aerophor does.

Now, gentlemen, I will explain to you the w Aerophor apparatus. As already indicated to yo contains two distinct working parts, each of si independent of the other, and each being nec

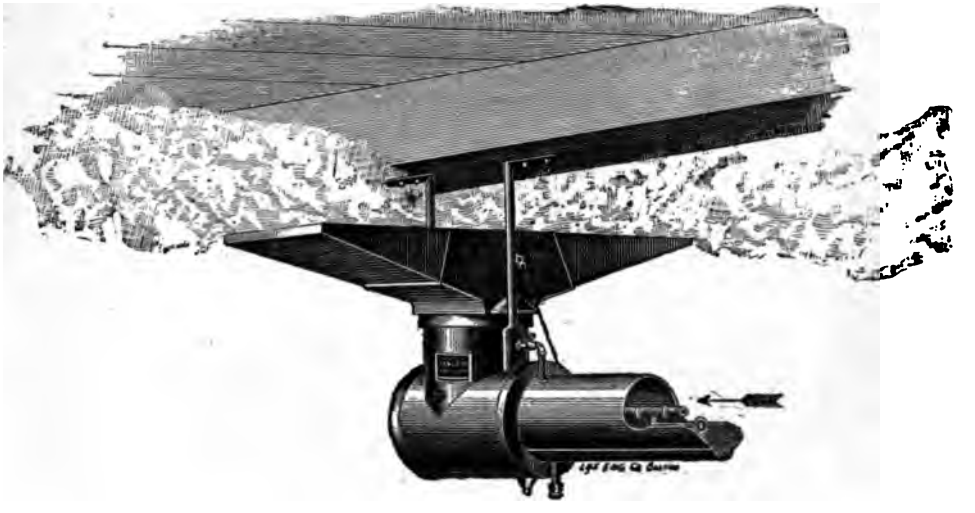
cessful working of the other: first, the central spray nozzle with impinging surface and means of regulation; second, the device for inducing the necessary distributing air current.

The Aerophor air-moistening apparati may be classified under two heads: first, "mechanical," in which the air current is induced by the rotation of a fan; second, "non-mechanical," where the air-distributing current is induced by a stream of water. In either case the central spray nozzle is the same. This consists of a circular nozzle, having some forty to sixty radial apertures, through which the water is forced against a circular impinging surface surrounding the same. The water is discharged from the apertures in the nozzle horizontally, and, in striking the impinging surface, becomes broken up into spray. This entire attachment is placed at the lower extremity of a suitable canal or tube. Said canal or tube contains the arrangement for inducing the distributing air current.

The mechanical Aerophor, before referred to, contains a fan driven by means of a small water motor attached thereto, the same pressure of water that supplies the "central spray nozzle" answering the purpose for driving the fan.

The non-mechanical Aerophor, which is the latest outcome of this invention, has no movable parts whatever, consequently no wear and tear, the distributing current being induced by the suction caused by a stream of water playing upon a cone placed directly opposite its outlet.

The Aerophor outlet head is so constructed as to distribute the atmosphere, after it has become moistened within the apparatus, in all or any directions that may be desired; and the regulation of such moisture is provided for by the closing or opening of a register, which in turn reduces or enlarges the air outlet.



There is considerable detail in the carrying out of this invention, and although at sight it may not appear that any great trouble or experiments were necessary to construct such a device, there are very many parts which, although apparently insignificant in themselves, are of sufficient influence to mar the practicability of the whole, had they not been properly considered.

First worthy of notice in this respect is the means employed for preventing the expulsion of any but the very finest of the

spray produced, and by which device any particles of water heavier than the atmosphere sink by their own specific gravity to the waste receiver provided for the purpose. This result is obtained by subjecting only the finer portion of the spray to the action of the air currents, and covering or protecting the coarser spray formed from such air currents, with the peculiarly shaped cover and register.

Another apparently insignificant but nevertheless important point, is the means whereby the condensed moisture at the point of distribution is prevented from being ejected into the room by the force of the air currents. This result is obtained by the sloping base and upwardly protruding lip of the distributing head outlet.

There are many other such details that have been the subject of much serious thought; but I will not take up your time by pointing these out to you, but will, by showing you the apparati in operation, give you an opportunity of forming an opinion thereon. It is sufficient to be able to say that I feel we have an apparatus here capable of fulfilling any reasonable demands that may be made upon it by a manufacturer desiring to avail himself of its advantages.

Proper tests and experiments have shown us exactly what quantity of air one such apparatus can displace, and actual measurements have proven beyond doubt what amount of water may be taken up and discharged with such quantity of air without danger of causing a surplusage of moisture in the atmosphere. Such calculations enable the manufacturers of this machine to calculate with actual reliability the amount of moisture they are able to produce and distribute under given conditions; and, by means of the regulating device attached to every apparatus, the moisture can be kept at any point desired, even to that of saturation, provided enough apparati are provided therefor. The Aerophor also acts as a ventilating and purifying device. The whole air of a room is passed in the course of an hour, some six or eight times, through the Aerophor, and in its passage is washed, purified, moistened, and may be disinfected if desired. Irrespective, therefore, of the advan-

tages of proper moisture on the product, the labor performed by the help under the influence of an exhilarating and healthful atmosphere is of a totally different nature to that performed under the depressing and nauseating influence of steam, which is, unfortunately, to-day the method most in use for moistening the air in mills.

In conclusion, I feel it but just to the interests of those connected with the Aerophor to state, that, while not wishing that this paper should be looked upon in any sense of the word as a desire to obtain gratuitous advertisement, they will still be glad to give any further information that may be desired with respect to this device, and are willing and ready to make equipments for those desirous of making a trial of this system, with the undertaking that, should the apparatus not fulfil the claims made for it, they will remove the same without any charge whatsoever.

I think the officers of the Aerophor Company may, under these circumstances, be justly credited with sincerity of belief in their system, judging by their willingness to substantiate their assertions at their own risk.

Mr. GARSED. Some years ago an effort was made to overcome the trouble from the coal dust under our boilers. The patent called for a number of jets, or sprays of water; which we introduced, through four or six foot gas burners under the grate. We soon discovered that the mucous substance or impurities in the water choked these burners up so that we had to change them three or four times a day; and it looks to me as though a similar result would follow in this case, unless the water was purified by distillation or some means by which you would have pure water, and not be subjected to the liability of choking up the burners.

Mr. KLABER. May I be allowed to state, gentlemen, how the difficulty is overcome? By the peculiar form and construction of the nozzle, the water does not emanate from holes, although apertures are formed that are the equivalent, in every sense of the word, of holes. These nozzles are formed by the laying together of two surfaces. One of these surfaces is grooved, — the lower one, — and the upper surface is flat; and, when they come together, an aperture is formed through which the water emanates. But yet, although we use a larger filter, the fact remains that from time to time the nozzles do become stopped up. The only thing we have to say on this is that the cleaning of these nozzles is reduced to such a simple matter that it gives practically little or no trouble. By releasing a screw, the apertures are exposed, ready to be cleaned or brushed, as may be desired; and in this device forty such apertures can be cleaned at one and the same time. I am not a finished mechanic, but I will undertake to clean one of these nozzles perfectly in two or three minutes.

Then there is another advantage, in addition to the facility with which it may be cleaned, and that is, that the apertures through which the water emanates are smaller than they could possibly be bored. The grooves are made with a very fine watchmaker's file; and, when closed, the apertures formed could not be bored in metal so minutely. The groove is in the lower ledge, and the flat ledge lies on top; so forming an outlet where the groove is.

A MEMBER. What pressure is desired?

Mr. KLABER. From seventy to ninety or ninety-five pounds. The average pressure is eighty pounds.

A MEMBER. How much water is required for an instrument of that nature?

Mr. KLABER. The machine requires about one hundred and twenty-five to one hundred and fifty gallons an hour. After the water has been used, there is a return pipe by which it is led again into the reservoir, and is pumped up and used over again.

Mr. SAUNDERS. I would like to ask you, if a spinner or carder had this apparatus in his room, how he would know when to turn it on or shut it off? If our observations have been of any value, I found that from five to six and one-half grains of water in a cubic foot of air is the best condition to run our mills. The work will run better there than at any other point. Now, how will they know how to regulate it?

Mr. KLABER. Mr. SAUNDERS has touched upon a point which I referred to in my paper. I believe I stated that this is the only apparatus which can be regulated to any extent, and can be shown by a hygrometer. Now, I think it may be interesting to you to hear something of my experience with regard to the hygrodeik. Mr. SAUNDERS has read a paper on the tests he has made with a hygrodeik. I would say here, as justifying these remarks, that I am connected with a business which supplies duplicating devices to the Signal Service of the War Department. We have, by delivering these machines to the government offices throughout the United States, become intimate with a great many of the superintendents of stations; and I may mention Superintendent DUNN of New York, to whom I am indebted for the information I am about to give you. I have found, in visiting many mill men, that they have referred me to tests and measurements taken with the hygrodeiks, — that is, the wet and dry bulb thermometer. There is an impression that that is the best instrument for estimating the humidity in the atmosphere. Now, generally, the wet and dry bulb thermometer is the most reliable

ment that is made for the purpose. The measurements and results that are obtained from it are the most unreliable that can be produced, and the reason of that is this. The results are dependent upon a wet and dry bulb thermometer. The signal office, in taking measurements from this wet and dry bulb thermometer, take that wet bulb and wash it out thoroughly, so that no particles of dust are on it. They have a device by which that thermometer is whirled through the atmosphere for a specific purpose. And yet I have found in many mills that results have been taken and looked upon as reliable, when the wet and dry bulb thermometers have been in such a condition that they would indicate a state of things which never existed. The slightest deposit of dust or fly upon the wet bulb of the thermometer will retard the evaporation of the moisture into the atmosphere, and the comparative reading of the wet and dry bulb thermometer will indicate an incorrect amount of relative humidity. The point raised by Mr. SAUNDERS is a very important one.

Mr. SAUNDERS. Mr. President, in regard to revolving the thermometer, I will say that, in taking readings for the Board of Health of Lowell, during the time when the atmosphere was at the freezing point, I rotated it through the air four hundred times per minute with a machine made for the purpose, and watched it very closely. While I am very much interested in Mr. KLABER'S explanation in regard to the wet and dry bulb thermometer, I must say it is the only instrument we have that we can possibly get in our mills to determine what the atmospheric changes are. Now, by rotating my wet and dry bulb thermometer in the open air, which they do at the signal service in Boston, I find that the difference is very slight from rotating my wet and dry bulb thermometer from what it is in my mill. Of course, if we intend to make application of these papers, and if we intend to get the amount of water vapor that is constantly changing, we must take care of our instrument. It would be useless for us to put a number of hygrodeiks in our mills, and let them run themselves. They must be taken care of, and with a little care they will run very

well. I should say that the minute changes that the signal service observe in making up their weather reports we could not observe, because it would not be necessary, and because atmospheric changes come so often; but we need to keep our atmosphere and humidity within a certain limit. Now, if that apparatus will do that, of course we gain a point; but I think in the first place we must know just about how much we want, and how much we do not want.

Mr. KLABER. We are able to estimate with this machine how many apertures are needed to produce a certain amount of moisture. Of course, the natural conditions of the atmosphere vary; so, of course, to that extent our apparatus is regulable. This is one of those things where experience and good intentions will ultimately come out triumphant. But we claim (and I think I am entitled to state, that in Germany they have succeeded in doing that which we think we will be able to do) to be able to give any man the exact condition of temperature and humidity he may need. We can also warm the water by the introduction of a steam pipe into the reservoir, by which the water, when discharged in the form of water, does not have that coldness that it would have had if taken directly from the reservoir.

A MEMBER. In referring to instruments for measuring the humidity in the air, Mr. SAUNDERS and the other gentleman are talking about scientific instruments. Now, if we had to wet down our clocks in the mills in that manner, I do not believe our overseers would know what time it was. I want to know if they have found a machine that will regulate approximately the humidity in the atmosphere, that I could read at any hour of the day, without any special care except to keep it dusted off, as we would the clock?

Mr. KLABER. We have such an instrument, as I said before, but sometimes it will not act as it should; but, so far as I know, there is not a machine to-day that will indicate the relative humidity more satisfactorily. But we would ask mill men to look at actual results; not to depend so much on measurements, but to see where it is working evenly and

smoothly. Practical results are what we want, without going into an argument as to the best devices to show in figures what the best humidity may be. We are able, by means of the Aerophor, to provide moisture in the weaving and other rooms where it is advantageous; and we are ready to put up machines in any mill to show whether our statements are well founded, and will take them down again if they are not; without any charge either for putting up or taking down.

Mr. SAUNDERS. In regard to the last inquiry, I will say, any ordinary wet and dry bulb thermometer will give the changes that will occur in a card-room or spinning-room sufficiently to know what to do. I think that is about all we can do. If we have our instrument in proper condition, with clean water, distilled water, and the wick kept perfectly clean, as we see by the reading of that paper, it shows pretty conclusively that a wet and dry bulb thermometer will be sufficient, and that with a little care almost any overseer would be able to control it.

A MEMBER. In our experience the wet and dry bulb thermometer was not taken care of unless we had somebody especially to take care of it. In looking over Mr. Saunders' paper, and comparing the readings we took in our mills on the same day in Connecticut, I find that the Wamsutta Mills compared quite closely with the readings we took with that instrument in our spinning-room. I think it did not vary more than four degrees on the same day and the same time of day.

The PRESIDENT. Has any other gentleman a word upon this subject? If not, we will take up the next subject on the programme. Mr. W. H. DODGE of Indiana will present a paper on ROPE DRIVING.

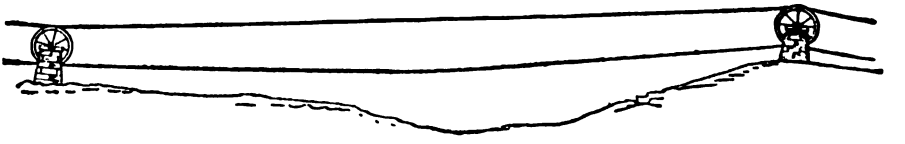
TRANSMISSION OF POWER BY MANILA OR COTTON ROPES.

By WALLACE H. DODGE, Mishawaka, Ind.

For the transmission of power we have had, for ages, two main methods employed, viz., toothed gearing and the horizontal revolving shaft with the pulley and belt. These are only capable of transmitting power very short distances unless with the most serious losses or waste by the absorption of work of the motor in torsion and friction of the gearing and shaft, and in friction, flexure and slippings of the belt, etc. Until within a few years, toothed gearing, either as spur or bevel wheels, or a combination of both, has been almost universally employed for first motions, the smaller powers being taken off pulleys by leather bands or belts. The facility of taking small powers off pulleys to machines by means of belts, and the absence of noise and vibration, led to the adoption, in the United States of America, of broad leather belts for the transmission of large powers from the prime mover to the shafting in factories; but the mechanical difficulties attending the transmission of large powers by means of large belts, have, for a considerable time, interested mechanical engineers in efforts to find a satisfactory substitute.

"The first systematic attempt to substitute a ro
kind in place of belts or shafts to transmit power fi
to machinery at a distance was made by Mr. C.

Logleback on the Rhine. The experiments which finally resulted in success extended from 1852 to 1860; for, notwithstanding the apparent simplicity of the proposition, there were serious and unexpected mechanical difficulties to be overcome. It has been said that the gist of this invention is in a very simple principle, viz.: the substitution of velocity of motion for mass of matter moved, because a given force may be equally well represented by a heavy body moving slowly or a light body moving swiftly. Thus it may be said he imparted portability to his force, since it may be neither practicable to move the motor to the work nor to transmit its motion through slow-moving heavy shafting."



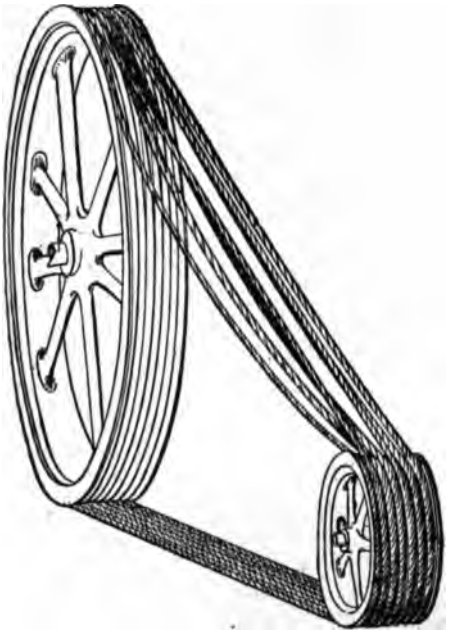
Hirn Teleodynamic Cable.

The cable employed was of wire about 1 c. m. in diameter, and bearing pulleys were placed about one hundred and fifty yards apart.

The transmission of power by Hirn's Teleodynamic cable has been frequently employed in this country, but cannot be said to have met with a success commensurate with its great promise. This is largely due to the rigidity and great weight of the cable. Its rigidity resists flexure around the terminal pulleys, and its great weight and velocity generate strong centrifugal force as it passes around the pulley to reverse the direction of its motion. Both of these add to the load of the motor.

The use of wire ropes for transmitting power is, practically, limited to long spans, and has not been found to be adapted to take the place of belts. But ropes had long been used to drive small machines and in a large way for cable haulage in mines and on inclined railways. Hemp and cotton ropes have been employed for this purpose in England for several years. The distinguishing feature of the English system is the duplication of individual rope belts when the power to be transmitted

exceeded the capacity of a single rope of convenient size. It is evident the diameter of the rope is an important factor in rope transmission, because in passing around the terminal wheels the effects of flexure are in proportion to the diameter of the rope. In our practice the diameter of the terminal wheels is not less than sixty rope diameters, and the importance, if not the necessity, of small ropes is therefore at once perceptible. Hence when, under the English system, the power to be transmitted exceeds the capacity of one rope belt of convenient size, another rope belt is added, and so on.



English System.

This system has several disadvantages, among which ar-
inent the impossibility of securing uniform tension on
eral ropes, and the multiplicity of splices. Neverth
quite extensively used in Europe and the East, but l
received with equal favor in America. As a mat
the American engineer not being hampered by the

of established custom, has preferred the wide flat belt to the English duplicate round belt; but the modern growth of mechanical science in this country has led to many experiments looking to an avoidance of the cost and mechanical losses attending the wide belt. The outcome of these experiments is the American system of rope transmission, originated by the Dodge Manufacturing Company, of Mishawaka, Ind. It employs but one rope, however many wraps may be required to transmit the given power, and by a system of winders the ropes pass the terminal wheels as many times as may be required to secure complete adhesion and entire avoidance of slip. This invention was patented in 1885, but has been greatly improved since that date and made the subject of several additional patents. Probably the most important is the system of double wind whereby the splice is relieved of one-half the strain to which it might be subjected under the older system by variations of load.

With this brief notice of previous systems of power transmission by means of ropes, I will leave them and confine myself to the American system, which by its practical success in transmitting power over long distances, and in supplanting wide belts for short distances, has earned its title as a distinctive system.

This method of transmitting power depends upon two principles in mechanics: —

(1) The dynamic force is measured by the product of the force and the velocity with which it moves.

(2) In mechanical work power may be exchanged for velocity, and velocity for power.

The hidden principle involved in this system may be made plain by the following illustration, taken from Van Nostrand's Science Series: —

"To illustrate, let us suppose a bar of iron, having a cross sectional area of one square inch, to move endlong at the rate of two feet per second. Now, if the resistance overcome is, say, 5,000 pounds, work will be performed at the rate of 10,000 foot-pounds per second. Now, if we double the velocity of the bar, we will transmit twice the amount of work with

the same strain, or the same work may be produced with half the former strain; *i. e.*, by a bar having an area of only half a square inch. In a similar manner, if we move the bar with the velocity employed in teleodynamic transmission, viz., about eighty feet per second, then, while doing the same amount of work, the strain on the bar will be reduced from 5,000 to 125 pounds, and the bar will need a section of one-fortieth of a square inch. To put an extreme illustration, we might conceive of a speed at which an iron wire, as fine as a human hair, would be able to transmit the same amount of work as the original one-inch bar.

"By the application of these simple principles in Hirn's apparatus, the greater part of the force is first converted into velocity, and at the place where the power is required, the velocity is changed back into force."

The employment of repeated coils for the purpose of increasing friction is an idea which has often been employed for many purposes, and its origin is apparently unknown. The principles upon which it is based, however, are not as well known, perhaps, as they should be, and a brief examination of the subject may be of interest.

Everyone who has seen the operation of bringing a vessel to her moorings has noticed the ease with which the strength of a single man can be used to withstand the momentum of a heavy vessel when aided by the friction of a few turns of a rope about a post.

A few experiments will serve to show the rapidity with which frictional resistances can be multiplied by this method, and the practical application will become obvious.

If a cylindrical drum, placed in a horizontal position, be fixed from revolving, and a rope thrown over it, with weights attached to each end of the rope, the tension produced by the weights will cause friction to be generated between the rope and the drum.

If we take the coefficient of friction at one-third [illegible] sure produced by the weights, which on smooth surf[illegible] far from the truth, a given weight on one side will [illegible]

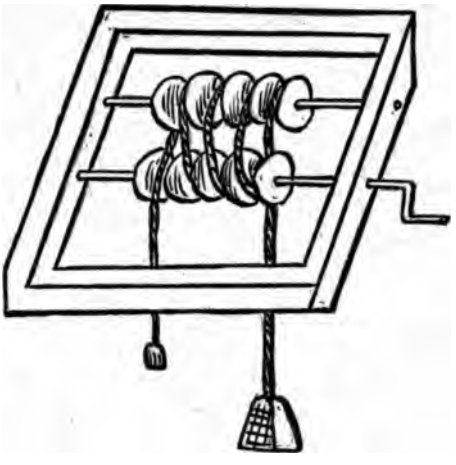
weight three times as large on the other side before any slipping takes place.

In this case the rope only embraces one-half the circumference of the drum. Now, if we pass the rope completely around the drum, we will find that one pound tension will support nine pounds before slipping, and that every whole coil multiplies the friction nine times, and every half coil multiplies it three times. These are only round numbers, but Professor Weisbach has investigated the subject thoroughly, and the following table, calculated from his formula, will show more accurately how enormously the holding power of friction may be increased by repeated coiling: —

Coils.	Weight Supported.	Coils.	Weight Supported.
One-half, . . .	2.85	Two and one-half, .	187.93
One, . . .	8.12	Three, . . .	535.43
One and one-half, .	23.14	Three and one-half,	1,525.97
Two, . . .	65.94	Four, . .	4,348.56

This arrangement of stationary drum and slipping rope, of course, has but a limited use, and so efforts have been made, more than once, to make the principle more general in its application. One of the earliest applications was made in the capstan of a ship; but the difficulty there appears of the tendency of the coils to travel along the axis of the winding cylinder. In order to meet this objection, the capstan is made tapering, and when the coils have wound along to the large end they are pried back again to the small end, and this operation is repeated as often as necessary.

As long ago as 1670 the famous architect, Sir Christopher Wren, read a paper before the Royal Society, upon a method for obviating this objection; and, as the communication is both short and curious, I reproduce it from Willis' Mechanism, with its quaint spelling and rough engraving: —



"A Description and Scheme of Dr. Wren's Instrument for Drawing up Great Weights from Deep Places."

Read May 5, 1670.

"Having considered that the ways hitherto used in all engines for winding up weights by roaps have been but two, viz., the fixing one end of a roap upon a cylinder or barril, and so winding up the whole coyle of roap; the other, by having a chain or a loose roap catching on teeth, as is usual in clocks; but finding with all that both these wayes were inconvenient, the first, because of the riding of much roap in winding one turn upon another; the other, because of the wearing out of the chain or roap upon the teeth, I have, to prevent both these inconveniences, devised another, to make the weight and its counterpoyse bind on the cylinder, which it will doe if it be wound three times about.

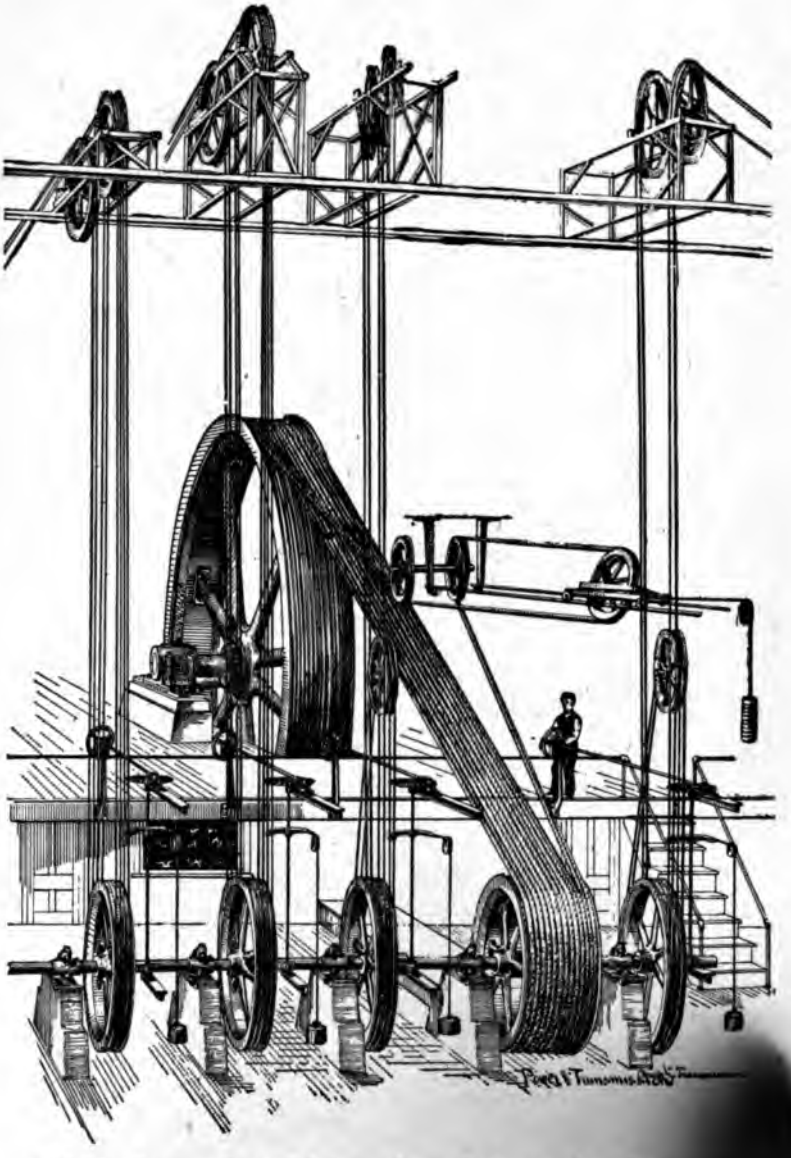
"But because it will, then, in turning, scrue on like
and will need a cylinder of very great length, there
two cylinders, each turned with three notches,
be placed alternately, the convex edges to th
the figure here adjoined, the roap being w
about both cylinders, will bind firmly wit
work up the weight with a proportional
the other end of the roap."

Since Wren's time the arrangement has met with numerous applications, but they appear to have been confined to winding systems. When applied to continuous motion, however, as in the manila rope transmission system, the advantages are most apparent.

In the study of belt transmission the amount of friction between the belt and pulley governs the transmitting capacity; but in the manila rope system the principle of multiplied coil friction adopted renders it possible, with a few turns, to remove all possibility of slipping, and the transmitting capacity becomes merely a question of the tensile strength of the rope, and the velocity at which it moves; so that the whole subject is entirely under control.

In this way the old principle has met with a new application which bids fair to extend its usefulness to a greater extent than ever before.

But to eliminate theory as far as possible and come down to the plain facts, which will be more interesting to you than any unverified theoretical discussion can be, I will now describe the American system as it is in use in the works of Dodge Manufacturing Company, and where you are, individually and collectively, cordially invited to inspect it at any time when your convenience shall enable you to do so.



This is the most complete and perfect sample of powe
tribution in the United States, and it is doubted if it
equalled elsewhere in the world. In the illustration, wa

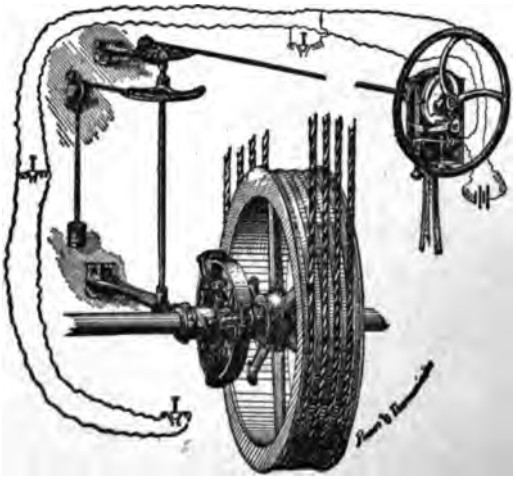
titions and prime mover are omitted. The great driving wheel takes motion direct from a 450 horse-power Corliss engine. It is 22 feet in diameter and weighs 27,000 pounds. It has 14 peripheral grooves for the one and one-fourth inch main driving rope, which is endless, and passes fourteen times around the driving and main driven pulley on the jack shaft. It also on its course passes around the main slack take-up, which preserves a uniform tension on all parts of the rope.

From the jack shaft, power is distributed to various departments of the works by separate transmissions, the driving wheels of which have each a friction clutch whereby they may be coupled to or liberated from the jack shaft without disturbing the motion of the engine or other distributing transmissions. This economizes power by making the connections near the prime mover. On the drawing, four of these supplemental transmissions are shown. They pass from the jack shaft vertically about 50 feet to the leaders in the tower, and then pass direct in four different directions to the driven shafts, the furthest being in this case more than 600 feet away. It will be observed that while two strands of the driving rope transmit the power there are four strands around the wheel on the jack shaft. The extra two pass around winder wheels, two of which are shown separate from the leader wheels, and are used solely for the purpose of increasing area of contact with the driver (and the same at the other end to secure increased contact with the driven). The number of such extra passages may be more or less, as may be necessary to eliminate the slip. The leader wheels may be set at any angle as to the axis of the driving wheel, and therefore the power may be transmitted in any desired direction without limitation.

Distance and direction are practically immaterial, and the loss in transmission is confined to aerial friction and the friction of bearer journals, slip being eliminated. These advantages being demonstrable, it has naturally followed that this way of transmitting power has been adopted for long-distance transmission more rapidly than in locations where belts can still be employed without marked difficulty. In connection

with rope transmissions over considerable distances, the friction clutch has assumed a new importance as a factor in the distribution of power; and the long transmission with the friction clutch, rendering it possible to concentrate the power in a single source and distribute it from a central station, renders electricity, as a means for control, of importance only second to the rope as a transmitter. Under the old systems, and under all the present systems of rope transmission except the Dodge American System, the engineer is depended on to disconnect or connect the transmission with its driver. Necessary communication is usually by means of a signal bell worked by the pull of a wire. In a few instances the signals are transmitted by electricity. At the best this is a slow method, altogether too slow when prompt action is necessary to save life or destruction of property. At the moment of getting the signal the engineer may be engaged, and in the absence of any knowledge of special necessity for haste precious moments may be lost before the clutch is thrown out.

To obviate these difficulties and to give direct control of the transmission to those at the driven end of it, Dodge Manufacturing Company have an electric let-off, by means of which the clutch may be thrown out instantly, by closing circuit at any one of several places located about the works at convenient points.



In this instance the clutch lever is provided with a short rack, and a pinion on an upright shaft meshes therewith. The upright shaft carries a rope segment and a bevel wheel at its top. A rope on the rope segment carries a weight sufficient, when liberated, to pull the clutch out. The bevel wheel at the top of the upright shaft meshes with a pinion on a horizontal shaft, the other end of which enters the let-off box and carries the stop wheel, which is arrested and held by a pawl within the box. There is also a hand wheel by means of which the clutch is "set" and the weight wound up. When so "set' and wound up, it is held by the pawl in engagement with the stop wheel. As will be easily perceived, the pressure upon the end of the pawl will be considerable, and to disengage it by a direct electrical pull would require an undesirably large battery power. The required liberation is therefore effected by a dropping weight and the force of the blow, which within a small compass may be rendered more effective than a single pull. The weight consists of a rod which may be weighted to any desired degree. It is sustained by a hooking lever the end of which is supported by a swinging armature latch. An electro magnet in the electric circuit withdraws the armature latch and liberates the dropping weight whenever circuit is closed at any closing point in the circuit, and these points may be as numerous as desired and placed at such points about the works as may be most convenient.

For convenience, an electrical annunciator is also placed in the circuit in the engineer's room, and he is thereby informed when a clutch has been "thrown out," and also signalled when it is desired to "hook up" again.

In the above we have described the gear as it is set up under the particular arrangements in Dodge Manufacturing Company's works. It is evident the connections between the let-off box and the clutch may be modified to suit the circumstances of any case.

It is one of those conveniences which become necessities as soon as used; and no user of one of these transmissions and electric let-off systems would be willing to discard either under

any circumstances. It is an instance in which the cost of maintenance sinks into insignificance beside the advantages derived from its use.

Applications.

The process is far cheaper than any other system for long-distance transmissions, and is fully as cheap for short distances as belting, and about 15 to 20 per cent. more efficient, as no loss is sustained by rapid bending of the belt or slip to overcome its thickness. For in case a transmission is rigged for a 500 horse-power transmitter, more or less, and a given number of wraps of rope and tension weight proper for such a power is used, it may, without expense to journal friction, be changed to 200 horse-power by relieving the tension weight and thus converting, at will, a heavy transmission into a lighter one, with a large saving in power.

As a matter for comparison I will submit the following in the main transmission at the Dodge Manufacturing Company works: —

To transmit the same power with a rope *versus* a like power with a wide belt, —

(1) Requires much narrower-faced pulleys; consequently less expensive.

(2) The interest on the money required to be invested in a large belt will more than supply the rope, saying nothing about wear and tear.

(3) Better power by fully 15 per cent., from the fact that all slipping of the belt is overcome, and the rope gear, if of sufficient capacity, becomes as positive as a cog gear.

(4) The transmission in question consists of a series of grooved wheels and a cotton rope; the driver, 22 feet diameter, 14 grooves, driven 8 feet diameter, 15 grooves, winder pulley used to convey the rope to the slack carriage; this together with the carriage pulley are each two grooved and 60 inches in diameter. The device for taking care of the slack and giving the proper tension to the rope in a movable carriage [illegible] which works automatically, being impelled by a con[illegible]

This apparatus including as above: —

One 22′×14 groove wheel, 27,000 pounds, cost 7 cents, . .	$1,890 00
One 8′×15 groove wheel, cost, ...	212 00
Two 60″ idlers, cost $30 each, ...	60 00
One carriage with track, etc., cost, ...	100 00
403 pounds cotton rope at 22 cents, ...	88 66
	$2,350 66

Millwright work about the same as for a belt transmission.

Total cost of rope drive, $2,350.66.

To put in a belt drive with same speed would have required: —

One 22′×40″ face wheel, 30,000 pounds, cost 7 cents, . .	$2,100 00
One 8′×40″ face wheel, cost, ...	356 00
132½ feet 40″ double leather belt, cost $6.30 per foot net, .	771 75
	$3,227 75

Probably a tightener would be required, costing at least two or three hundred dollars more.

The above apparatus was erected and started in December, 1888, and has been running constantly since with the same six splices and transmitting an average of 450 horse-power.

The rope, when first put on, was allowed to run until the outside threads became worn and looked woolly. The rope was then treated to a bath of filler compound of tallow, beeswax, molasses and rosin applied hot. It now has the appearance of worn rawhide, and in fact is beautiful. It shows no signs of wear and looks as though it would last for years to come.

The rope drives from the jack shaft, shown in the large cut, are all manila ropes manufactured from the best selected long fibre, and in laying them up they are filled with tallow, paraffine and steatite, which lubricates them and prevents grinding out. These several drives have been in constant use since 1888, and are still running with their original splices. They are apparently as good as new. I will add, they have been treated with the mixture named, tallow, molasses, rosin, etc., as often

as once in five or six months. With reference to the durability of manila I will here quote a letter received from the Knoxville Woollen Mills, Knoxville, Tenn: —

SEPT. 29, 1890.

DODGE MANUFACTURING COMPANY.

Gentlemen: — Yours of the 16th inst. received. You only enquire as to the rope drive for looms. We wish to speak of both. The main mill is being driven by ¾″ diameter manila rope of your make, and has given entire satisfaction. We are using the first rope put on just two years ago. We think it has about done its duty and on general principles will renew it soon.

. . . . . .

Very respectfully,

KNOXVILLE WOOLLEN MILLS,

R. P. GETTYS, *Vice-President.*

The old song says, "The mill will never grind with the water that has passed," but this, like many other old-time axioms, has proved to be erroneous. It has been no small part of the mission of the American system of rope transmission to show how the mill may use the same water over and over again.

At Buchanan, in the State of Michigan, at the flour mill of Bainton Bros., three years ago, a second dam was built 1,100 feet down stream from the main dam, and the power of a second water wheel was carried back to the mill with an American system rope transmission put in by Dodge Manufacturing Company, thus enabling the power of the water to be used again after it had passed. When more power shall be required, another dam and another transmission will provide it. But an interesting incident of this transmission must not be overlooked. Two years ago a freshet carried away the main dam, and, while it was being rebuilt, the second, with its transmission, continued to run the mill.

When the transmission covers a long distance, economy and convenience require that the power shall be carried over by the fewest possible passes of the rope, and it was, at first, usual to employ a single rope, having a diameter sufficient to carry the power, using winders at each end to obtain the required adhesion to the driving and driven wheels.

It is manifest that the splice must be the weakest point of the rope and that it will be most likely to fail at that point while it is passing the laboring side of its circuit. It will be equally evident that a failure of the rope, while under greatest strain, will be most likely to lead to disasters.

To reduce this liability to the lowest point, we therefore resort to what we term a double wind. That is, the rope passes twice between driver and driven, and the laboring strain is divided. Several important points are gained. The cost is not increased materially because a smaller rope may be employed. Only one-half the laboring strain is imposed upon the splice, and smaller wheels may be employed.

The value and importance of the American System of Rope Transmission is shown by the fact that this system originated with the Dodge Manufacturing Company only five years ago, and has only been before the public about four years, during which time not less than twelve to fourteen hundred transmissions have been sold by this company, and a number of imita-

tors have been attracted to this new field. Imitation is the sincerest testimonial to novelty and utility.

The advantages to be derived from rope drive are numerous, and to summarize: —

(1) Small first cost, which also applies to renewals.

(2) Losses of time by stoppages reduced to a minimum

(3) Small space required for large powers.

(4) No slip.

(5) Light running, less noise and a more positive drive.

(6) Adapted to carry any power any distance and at any angle.

(7) A saving of fully fifteen per cent. of power under the most favorable circumstances for a belt, and in some cases would equal fully sixty per cent. saving in power, as in long distances.

I have written thus fully in reference to the American System of Rope Transmission, not because it is my wish to foster or bring to the front any particular patent, but as there appears to be an especial interest manifested in rope driving, and, as far as lay in my power, to oblige your worthy association.

Mr. WOODBURY. Mr. President, I should like to ask Mr. DODGE two questions; the first in regard to what he has found to be the preferable form or angle for the groove in the pulleys transmitting the power by rope, and, secondly, what he considers the safe and desirable strain to be applied to ropes in transmission. That is, what portion of the breaking strength of the rope is it safe to apply?

Mr. DODGE. We have adopted, in our practice, the United States Standard V thread angle (of about sixty degrees) for the grooves in our wheels; one that allows the rope to bind firmly on two sides, and, at the same time, will lift easily out of the groove, without any stick or hang, after having done its work. In answer to the second part of the question, we assume that it is safe to use, in indoor practice, from two to three per cent. of the breaking strain of the rope; and in outdoor practice, as in long-distance transmissions, a greater per cent. may be used; say from three to five per cent. of the breaking strain of the rope.

Mr. DODGE then explained a device in use in his company's works, whereby notice was given to the engineer, by an electric alarm, in case a breakage of the fibres of the rope should take place, causing the least strand of the fibre to stick out so as to strike the device and instantly alarm the engineer, and also automatically throw the clutch out of friction and stop the transmission, thus preventing damage.

Recently we had a boy, wiping the machinery, who let a small piece of waste get fast on the rope, and, as the rope came around, it struck the tell-tale (as we call it) and automatically threw out the friction clutch and turned in the alar was supposed that the rope had given out in some examination the little piece of waste was foun tell-tale. It was not more than two or tw long, very light, perhaps four or five t piece of waste set the alarm bell to ringi stop until attended to. I cite this little perfectly under control a rope drive ma

break occurs in the rope, it is but a few minutes' work to resplice it; and I think the liability of a rope breaking is less than that of a belt.

Mr. GARSED. If you have a continuous rope passing twenty-four times around a drum, that would be one twenty-fourth of a belt transmitting the same power. Now, if that rope breaks, the whole power of the machinery is relieved, and the engine continues on under that pressure. Now, I claim that a twenty-four-inch belt would not be so apt to break without showing it as one twenty-fourth part of the rope. Which would be most likely to give out, — a belt twenty-four inches wide, or a rope of one inch?

Mr. DODGE. We are using, in our main transmission, a rope of about that size, and we are using only one or two per cent. of the strength of the rope. When a belt is used for a like transmission, the same will hold good (one or two per cent. only being used); but the belt is required to have a large surface in contact with the wheels to transmit the power, and must usually have a large, heavy tightener, which makes the belt more liable to breakage. The labor of the rope being very light and of even tension, it is not liable to break, or, at least, not any more so than is a belt.

A MEMBER. Mr. Chairman, it would be interesting if Mr. DODGE would tell us something about the difficulties to be overcome in running his rope out of doors; how much the atmospheric and climatic effect is upon a rope, — snow and rain.

Mr. DODGE. The atmosphere does not affect the rope to any great extent, as a rope will run just as well out of doors as in doors. My theory is that when a rope is constantly bending around a wheel, either in or out of doors, air is being constantly worked through it, and serves to preserve it. If a new rope should be hung up in an old apple tree, it would deteriorate very rapidly, and would be worthless in a short time; but, on the contrary, we have ropes running that have been doing so constantly for two or three years, out of doors, and are apparently in good condition. However, a rope running out of

doors should be treated to a bath of filler compound of tallow, beeswax, molasses and rosin, as often as once in three or four months. I do not know that this is necessary, but I practise it.

The President then introduced Mr. F. M. MESSENGER of North Grosvenor Dale, Conn., who read the following paper.

REPORT OF A SERIES OF TESTS OF SPINDLE OILS, CONDUCTED AT THE MILLS OF GROSVENOR DALE COMPANY, NORTH GROSVENOR DALE, CONNECTICUT, MAY TO OCTOBER, 1890.

By F. M. Messenger.

I am aware that the subject of lubrication has often been discussed by this Association. It is a question, however, that cannot be exhausted until inventive genius finds a perfect lubricant; one adapted to all the varying conditions under which it may be used.

About two years ago, Mr. W. F. Draper read a paper here, showing that, in running modern spindles, great advantages could be derived by using lighter-gravity oils than it had been found practicable to use with the Sawyer, Pearl, and other older forms of spindles. I presume that many, if not all, have since verified Mr. Draper's claims by common practice.

The following series of tests seem to indicate that the oil men have taken up this question; and, in their efforts to excel, have produced oils of somewhat heavier gravity, which surpass in results any of the samples tested by Mr. Draper.

In making these tests, one of a lot of frames made by the Whitin Machine Works was used; about five years ago they were remodeled by putting in new cylinders and Whitin gravity spindles; this frame contained 256 of these spindles; the cylinder was seven inches in diameter, the spindles were banded by what is known as the "Coggeshall method;" the

driving belt was three inches wide; and the frame pulleys were nine and five-eighths inches in diameter. We used an Emerson Power Scale in making these tests.

While testing, the rolls were always disconnected, running only the cylinder and spindles; the latter being loaded with empty bobbins. After each test the frame was connected and put to its regular work.

In changing from one oil to another, the spindles and bolsters were removed from the frame, the bolster cases pumped out with a syringe made expressly for the purpose, the oil was emptied and wiped out from the bolsters, and the spindles wiped; each one being carefully replaced in the case from which it came.

In our first series, each oil was tested for about ten days (with the exception of Nos. 4 and 7, which were discontinued on account of inferiority, and No. 9, which was received too late to continue to a full test), and the weighings were taken as near to 9 A.M. and 3 P.M. as practicable; two weighings were always taken, and if they did not agree, three, and sometimes more, were taken to insure accuracy. The flash and evaporation tests were made at the Institute of Technology, through the kindness of the Boston Manufacturers' Mutual Fire Insurance Company.

In the second series, each oil was tested one day; five separate tests were made, three with empty bobbins and two with bobbins full of yarn, but with rolls disconnected in each instance; each separate test lasted one hour, and eighteen readings were taken; the tests with full, and with empty, bobbins were taken alternately; we also used a flat bulb thermometer fastened to the bolster rail to register its temperature, noting the temperature of the room at same time by a thermometer hung midway of the frame upon the creel. The samples tested were selected from those used in the first s were renumbered for convenience; taken in their i they were Nos. 6, 9, 8 and 1 of the former serie are the results: —

First Series.

No. of Oil.	Gravity.	Test Commenced.	Hours Run.	Temperature.	Humidity.	Revolution Spindles.	Spindles Per H. P.	Flash Test.	Evaporation.
1	33	May 28.	101	88.7	55.	9,973	185.5	Not	taken.
2	35	June 9.	98	89.1	58.5	9,910	216.4	282	9.6
3	35	June 19.	95	89.4	59.1	9,967	248.	276	16.
4	32	July 1.	25	91.5	64.	9,949	171.5	Not	taken
5	32	July 7.	98	92.	57.	9,961	239.8	338	4.
6	32	July 17.	103	90.7	58.7	9,938	244.2	304	7.5
7	28	July 30.	55	93.	65.	9,887	182.3	Not	taken
8	33½	Aug. 26.	115	90.4	60.8	9,916	302.	292	6.3
9	35½	Sept. 19.	27	90.2	60.	9,900	272.5	318	7.2

Second Series.

No. of Oil.	Load.	Date of Test.	Temperatures.			Humidity.	Revolution Spindles.	Spindles Per H. P.
			Creel.	Rail.	Excess.			
1	Empty.	Sept. 23.	87.1	95.7	8.6	–	9,939	254.4
	Full.	Sept. 23.	86.5	95.8	9.3	32.4	9,913	168.9
2	Empty.	Sept. 24.	84.1	92.	7.9	–	9,933	262.6
	Full.	Sept. 24.	84.8	92.8	8.	32.3	9,922	171.8
3	Empty.	Sept. 25.	83.4	92.4	9.	–	9,943	269.2
	Full.	Sept. 25.	83.6	91.8	8.2	33.6	9,932	171.4
4	Empty.	Sept. 26.	84.2	97.2	13.	–	9,902	218.2
	Full.	Sept. 26.	84.5	98.	13.5	44.4	9,849	158.6

The President then stated that Mr. M. M. Laduc of Lowell, Mass., would explain a device connected with a frame loom in which he was interested; which the latter proceeded to do.

A MEMBER. Mr. President, I want to ask a question in regard to the machine we have before us for increasing the humidity of the atmosphere in the mill. I find that, if Mr. SAUNDERS takes the temperature and humidity of Lancashire, Eng., as a standard, it seems to me strange we should be compelled to increase the humidity of our atmosphere in our mills here. He gives as the water vapor in Stalybridge, the mean, 5.581 grains; and yet we find in the Wamsutta mills the mean is something over 7 grains; so that there is really more vapor, more moisture in the air, than there was at Stalybridge. Now, it seems to me that we not only require a machine for increasing the humidity of the atmosphere, but also for diminishing it, if these statements of Mr. SAUNDERS are correct.

The PRESIDENT. Mr. SAUNDERS, I have no doubt, can answer that inquiry.

Mr. SAUNDERS. Mr. President, I do not expect that I shall be able to answer all the questions that might possibly be asked in regard to a matter of this kind. In Stalybridge, Eng., or in Lancashire, where the temperature is about the same as in Stalybridge, you will observe by the table that the wind was south-west twenty-two days in the month of July; therefore we draw our conclusion that if in the month of July the wind was south-west twenty-two days, the humidity and temperature would run quite close. Now, in Lowell, you will see by the table, you cannot get any definite idea about the wind, because it is so changeable. Why I present those two tables is to show the extreme we have to contend with. The difficulty we have to contend with here in New England is, I think, in our changeable atmosphere; while in Lancashire, as you well know, it runs quite uniform. As to the amount of water vapor or relative humidity in New Bedford, we find that the conditions there are very much better than anywhere else probably in England. You remember that last year Mr. Atkinson

paper in which he said New Bedford was the best place to manufacture cloth; but you well know we cannot all go to New Bedford, but must manufacture in Lowell and Manchester, and all over New England, and in New York State, Pennsylvania and Rhode Island; and so we must adjust ourselves to the conditions, if we possibly can. Now, the point that the gentleman makes is, that the mean in New Bedford was about 7 grains, — is that so?

A MEMBER. Yes, sir.

Mr. SAUNDERS. While in Stalybridge it was only 5.5, and would indicate that we have a damper atmosphere in New England than in Stalybridge; we have had times in July when it has gone up to 10.5 grains. We run up as high as 9.5 in Lowell. Such days very rarely occur. It is very seldom we get a day where our instruments would indicate 9 grains. Our trouble is in the atmospheric changes. We start at 3.5 grains, and, unless we are pretty careful, we are apt to get light yarn.

Mr. MCARTHUR. Mr. President, we have listened attentively to the interesting papers read, and also to the discussion about the humidity of the atmosphere; and now we would like to know something about the humidity in the cotton; and some of the members would like to hear from Mr. BOURNE about that. I believe he has a very valuable method of regulating the whole matter of moisture in cotton; and I would be pleased to hear from him.

Mr. S. N. BOURNE. Mr. President, I did not expect to be called on. I invited Mr. MCARTHUR and yourself to see a little device I have. I cannot go into the matter of humidity, but I can tell you how the thing works. The old saying is, "The proof of the pudding is in the eating." Last year our cotton that we received was put up very damp, and when we came to use it there was a great deal of moisture in it, and it did not work well, and a good many of our neighbors had the same trouble. We opened our cotton out into piles and let it lie there, and had a man move it, and that made a good deal of labor. It struck me there ought to be some better way than that; and I made a movable platform, a movable platform that

will hold three days' work or a little more, — all I had room for. If I had room to have a week's work put on it, I should put it on.

A MEMBER. How many days?

Mr. BOURNE. About thirty days. We opened that cotton there. It is put on a pile there, and it is all loose, the air is all around it, and you can run your hand around it, and you are always using the oldest cotton, — three days old. By doing that we find that our numbers are very much more even than ever before known on the start, and no more attention is paid in the carding room to keep it there than before, and we laid it to that. When I did it, I did it to save labor. I did not expect I was going to receive the benefit I did receive from it in the fineness of the yarn. It is a very simple device, and Mr. PERHAM, of the Kitson Machine Company, is prepared to furnish it. I suppose he gets pay for it, and if anybody puts it in, and is not satisfied with it, he can blow PERHAM.

Mr. MCARTHUR. Mr. President, Mr. BOURNE has another point. He has not told us about his method of removing moisture from cotton in one peculiar instance.

Mr. BOURNE. I will say that we did let one bale go down the river. It went down to Lowell, and they did not want it there. It went down to Lawrence, and they caught it there, and sent it back; and, after being in the river three or four weeks, it came out just as good as ever.

Mr. SAUNDERS. I would like to say Mr. BOURNE has touched a point, I think, of great interest where cotton comes to us damp. I have been for some two years trying to ascertain the loss of water vapor or moisture in cotton from the time that it was opened, carrying it directly to the card where we were manipulating our cotton that had been the picking and carding rooms, and I found it ran per cent. Now, cotton when it is taken directly and carried into the card-room and placed a sample cotton, I always watch my instrument, what the variation is, and amount of tempera and I found that cotton would open, at times, v

moisture; that is, that per cent. of moisture would actually come out by carrying it directly to the card-room before it would come to the condition where we were carding cotton. Now, if we could just get into a condition to prepare our cotton in our picking department, or before it was picked, in fact, then I think we would be able to card it better, and make a more perfect yarn than we now do.

Mr. BOURNE. I believe, Mr. President, this matter of preparation of cotton for the pickers is a very important one, and I hope that this Association will take up this discussion again at the beginning, and work up through the different departments of the mill. We all know that when cotton is damp it works hard, it is more dense, and more fibres work in; consequently the work comes heavier, the yarn is heavy. When yarn is dry, of course there is less fibre, and we get lighter yarn. I think it is a subject worthy of our attention.

Mr. SANFORD. Mr. President, before we leave this matter of humidity and atmospheric conditions, I would like to say a few words. Mr. SAUNDERS has said all cannot go to New Bedford. I wish to say you can all come to Fall River. I manufacture there, as you all know, and manufacture yarns which require humidity. General GREELY states a fact of interest here. He says, somewhere on the elbow of Cape Cod is the spot to manufacture cotton; that is, the greatest relative humidity will be found there. He does not state where that spot is, but we feel that it includes New Bedford and Fall River; and, in proof of that, we have mills in Fall River which are producing as fine goods as can be produced anywhere else. And yet, with all these advantages which New Bedford and Fall River enjoy, there are times when they have to be assisted by some such apparatus as is exhibited here. I only wanted to bring my town into comparison with New Bedford. We believe that Nature has done as much for us in Fall River as for those in any other spot, for the manufacture of cotton; and I only pity those who are not located on our New England coast, and have not this humid atmosphere; and, if they have not, then they must produce it by some of the artificial appliances now in use.

Mr. GARSED. I think that the mills in Providence and Norwich, and the Thread Company at Holyoke, can spin fine yarn equally with Fall River and New Bedford. Modern machinery, in my opinion, will spin cotton almost anywhere.

The PRESIDENT. At the last annual meeting, the secretary made his report in regard to the loss to the Association by the fire in Sears building, and suggested that a reprint of certain proceedings of the Association should be made. Since that time he has sent out circulars, inquiring of the members their wishes in regard to that matter. He will now state the result that he has obtained.

The SECRETARY. The matter was brought before the Board of Government, and they were disinclined to take any action upon it without understanding what were the wishes of the Association; and therefore directed the Secretary to inquire by circular. Circulars were sent out, but were not so fully responded to as to indicate clearly what the wishes of the Association might be. The vote was almost equally divided. A second circular was therefore sent out, and the result is, that, out of some two hundred and forty members, two hundred responded. Of these, those who objected to an extra assessment for reprinting numbered one hundred; those who favored it numbered eighty-two. There were responses from twenty-one who expressed themselves as indifferent; willing to acquiesce in the action of the Association, whatever it might be. The vote therefore stood: No, one hundred; yes, eighty-two; indifferent, twenty-one.

The PRESIDENT. Does the Association desire to take any action in regard to that at this time? Under the circumstances, the Board of Government does not feel authorized to reprint the proceedings of the Association, and will not unless instructed by the Association.

A MEMBER. What is the assessment likely to be on e member for the expense of doing that?

The SECRETARY. The expense would be about fifteen lars. It was proposed to divide it into three assessme five dollars each.

Mr. GARSED. I move that the work be reprinted at the expense of the Association, as reported by the committee.

The motion was seconded.

A MEMBER. I would like to ask what they are to be reprinted for? Is it simply that the secretary may be supplied, or what is the object? I would suggest, if it is simply to supply the secretary, the members will be willing to do that. I have one whole set, and half of another set, which I will be willing to contribute.

The SECRETARY. Of course it is not a matter which especially affects the secretary, but he will simply state the matter as proposed by the Board of Government; that is, if the volumes were reprinted, to print such a number as would supply each member, and have a surplus on hand for future use, in case they were desired to be purchased by future members. Each member will receive an entire set in return for his assessment. By the courtesy of various members, the office of the Association is already supplied with a full set of the reports, for reference.

A MEMBER. As I understand it, there are about one hundred members who have been careful to preserve the records, and they object to being assessed fifteen dollars, while other members have not. I have been careful to save a copy of every meeting we have had here, with one exception, and I have them bound; consequently, I should not vote to have them reprinted at an expense of fifteen dollars to me.

A MEMBER. Will the secretary explain another matter, — how a portion can be printed to supply those who have not any? I am one who has not them. I think myself there will be some injustice in assessing a man fifteen dollars for a set, when he has one. I wish the matter might be presented so that we could supply those who desire a supply, and let them pay for them; if there is any method to secure that end.

The PRESIDENT. The secretary has explained that the printing of a few will cost nearly as much as the printing of three or four hundred.

Mr. GARSED. Shall we, or shall we not? I have a full set, and do not want another, but I am looking forward to the future. Of course I prefer to have them reprinted, not for any personal interest, but for future reference of future spinners.

The motion was then put to a *viva voce* vote, and the Chair stated that it was lost. The decision was doubted, and a rising vote was taken, in announcing the result of which, the PRESIDENT said: —

The vote seems to stand twenty-six in favor and twenty-five against; which corresponds very closely with the result the secretary obtained when he sent out his circulars. I shall declare the motion carried.

Mr. KLABER, Mr. SAUNDERS and Mr. DODGE are not members of the Association. They have given us some very interesting and valuable papers to-day, and I shall assume that it has been moved that a vote of thanks be extended to those gentlemen.

The motion was unanimously carried.

A MEMBER. It seems to me that this matter of reprinting the proceedings ought to be settled by a larger vote. For instance, circulars were sent out, and it appears one hundred members voted against it and only eighty-two for it; and now it is brought up here, and it appears only twenty-six vote for it and twenty-five against it. Now, assuming there are two hundred and fifty members, which I understood the secretary to say there are, it will cost three thousand, seven hundred and fifty dollars. It seems to me that that amount of money might be laid out to more advantage in results to the Association. I would like to see that vote tried over. It seems to me it ought to be.

Mr. SANFORD. As I understand the matter, this is referred to the Board of Government under Mr. GARSED'S motion; and I think, in view of the sentiment expressed here to-day, the

government would not feel very much inclined to go ahead with the printing of those reports.

Mr. GARSED. I move, Mr. President, that the vote be reconsidered, as it seems not to be satisfactory.

The motion was seconded and carried. It was then voted to lay the matter over until the next meeting, and the meeting then adjourned.

[No. 50.]

N. E. COTTON MANUFACTURERS' ASSOCIATION.

PROCEEDINGS

OF THE

TWENTY-SIXTH ANNUAL MEETING,

HELD AT BOSTON,

APRIL, 29, 1891.

PRECEDED BY

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1891.

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Theophilus Parsons	Lyman Mills	Boston, Mass.
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Haven C. Perham		Lowell, Mass.
John M. Pevey		Lowell, Mass.
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James Renfrew, Jr.	Renfrew Manuf. Co.	Adams, Mass.
Roscoe C. Reynolds		Lewiston, Me.
F. H. Rice	Holbrook Mills	W. Boylston, Mass.
Chas. H. Richardson	Appleton Co.	Lowell, Mass.
Howard Richmond	Crompton Co.	Providence, R. I.
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Louis Robeson	Appleton Co.	Boston, Mass.
John K. Russell	Grosvenor Dale Co.	Grosvenor Dale, Conn.
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Arnold B. Sandford	Globe Yarn Mill	Fall River, Mass.
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G. H. Sayward	Standard Yarn Co.	Oswego, N. Y.
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Arba C. Slater	Linwood Mills	Whitinsville, Mass.
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Geo. R. Stearns	Riverside Mills	Augusta, Ga.
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Wilbur A. Stiles	620 Atlantic Avenue	Boston, Mass.
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Charles E. Thomas	Clinton Manuf. Co.	Woonsocket, R. I.
E. W. Thomas	Lowell Hosiery Co.	Lowell, Mass.
D. M. Thompson	Mills of B. B. & R. Knight	Providence, R. I.
Samuel J. Thompson	Valatie Cotton Mills	Valatie, N. Y.
Osmon B. Tilton	Lynchburg Cotton Mills	Lynchburg, Va.
James P. Tolman	Samson Cordage Works	Boston, Mass.
William E. Trainer	Linwood Mills	Linwood Sta., Penn.
Edmund E. Truesdell	China, Webs'r & Pemb'ke M.	Suncook, N. H.
James E. Walmesley	Clark Thread Co.	Newark, N. J.
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John Waterman	Warren Manuf. Co.	Warren, R. I.
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A. N. Whiting	Whiting Mills	Oakdale, Mass.
William S. Whitney	Pocasset Manuf. Co.	Fall River, Mass.
E. B. Wilber		Uncasville, Conn.
Henry M. Wilcox	John Rhodes Warp Mill	Millbury, Mass.
Theop. W. Wilmarth		Saundersville, Mass.
Thomas Wilmarth	Saunders Cotton Mills	Saundersville, Mass.
A. S. Winslow	Crompton Co.	Crompton, R. I.
George Wood	Millville Manuf. Co.	Philadelphia, Penn.
C. J. H. Woodbury		Boston, Mass.
Daniel Wright		Adams, Mass.

Total number of Honorary Members 2
Total number of Active Members 252

CALL FOR MEETING.

Boston, April 1, 1891.

Dear Sir: — The stated Annual Meeting of the Association will be held at the Massachusetts Institute of Technology, Boylston Street, Boston, on Wednesday, April 29, 1891, at 10 o'clock a.m., for the choice of officers for the ensuing year and the transaction of other appropriate business.

The Board of Government takes pleasure in announcing the following subjects for discussion: —

Gen. William F. Draper of Hopedale, Mass., will give a brief History of Spindles.

Mr. Charles H. Fish of Manchester, N. H., will present a paper upon the use of Oil Fuel Under Boilers.

This will be followed by statements from other members, detailing their experience in this matter.

Mr. O. S. Hussey, engineer of the Thomson-Houston Motor Company, will read an article upon the Adaptability of Electricity to Mill Work.

Mr. Edward Atkinson will discuss the subject of Food and Feeding in Relation to Wages.

Examples of food cooked over a common factory lamp (such as is used where kerosene oil is burned for lighting), in what may become a workman's dinner-pail, will be furnished as a mere sample of what can now be done in a family, or upon a large scale.

Copies of the three first-named papers will be printed in advance of the meeting, and will be supplied to any member who shall apply for them to the Secretary.

By order of the Board of Government,

AMBROSE EASTMAN,
Secretary.

PROCEEDINGS.

Pursuant to the foregoing notice, the stated annual meeting of the NEW ENGLAND COTTON MANUFACTURERS' ASSOCIATION was held at the Massachusetts Institute of Technology, on Wednesday, April 29, 1891, at 10 o'clock A.M.

The President, Mr. WALTER E. PARKER, occupied the chair.

The call for the meeting was read by the Secretary.

Upon motion, the following were appointed a committee to nominate officers of the Association for the ensuing year: —

Messrs.	CHARLES H. MANNING,	Manchester, N. H.
	M. F. FOSTER,	Denison, Tex.
	WILLIAM J. KENT,	New Bedford, Mass.
	F. M. MESSENGER,	North Grosvenor Dale, Conn.
	EBEN S. DRAPER,	Hopedale, Mass.

The Secretary presented his annual report, together with those of the Treasurer and the Auditor.

Voted, That the reports be accepted and placed on file.

The PRESIDENT. While the nominating committee are preparing a list of officers perhaps it would be as well to take up the first paper on the programme, by Gen. WILLIAM F. DRAPER of Hopedale, entitled the "History of Spindles."

Mr. DRAPER. Mr. Chairman and Gentlemen: — Some twenty years or more ago, in the early days of this Association, I remember a discussion in which my respected father took a prominent part, on the question whether it was desirable that any man interested in a new machine or a new process should have the opportunity to come before this body

and read a paper stating the reason why his improvement or his process should be adopted. It was then decided, after considerable discussion pro and con, that that was a desirable course; that any one interested in a new invention would certainly have every reason to state all the desirable results which attended its use, while discussions and suggestions by practical men would serve as a corrective in case of exaggeration. I believe that that decision was a correct one, and under it I feel no diffidence in presenting to you a paper upon spindles, although I am very largely interested in their manufacture. In one sense, however, this paper cannot be considered as an advertisement. The history of spindles, of the improvement in spindles, simply represents an accomplished fact; it does not speak of a result yet to be attained.

One thing more before going on to the paper. I have been before you, gentlemen, and in almost all of your offices, many times during the last twenty years, to induce you to adopt some of these new and improved forms of spindles. At such times I used all the arguments in my power, and I have to say to-day that I never have appreciated the advantages of the spindles which our firm has introduced to the extent that I have done since investigating the facts and collating them in a paper.

THE HISTORY OF SPINDLES.

By William F. Draper, Hopedale, Mass.

I have been requested by your president to prepare a paper on the "History of Spindles," to be read at this meeting. A paper of this kind, if made full and reasonably complete, would be far more lengthy than any of you would care to hear, or possibly read. I shall, therefore, pass over rapidly the early developments of spindles and spinning, and give more time to the present highly perfected structures which are now in use in your mills.

Spinning as an art cannot be traced to its earliest conception, as it dates back of all existing records and traditions. The mummies of Egypt confront us wrapped in linen of superior texture, and in every nation the first advance toward civilization began with the use of woven fabrics.

The production of cloth of any kind requires the production of yarn in advance. Spinning is the art of producing yarn, and consists in methods of twisting short vegetable or animal fibres into a continuous thread. This invention has been discovered at different times by every intelligent race, and Columbus, when first landing on American soil, found the natives clad in cotton cloths.

To-day in different sections of the world may be found illustrations in actual use of every step in the development of the now nearly perfect machinery; the native Mexican, with her distaff, toiling not many miles distant from the Rabbeth spindle in a cotton mill. Whether the latter will stay in use as long as its older rival, time alone can determine; but I have no question but that it has already turned off more work, in its ten years of existence, than the distaff in its thousands.

The amount of human labor eased by modern inventions in this line is enormous. The prime necessities of life

food and clothing; and, although no development of inventions is likely to increase the capacity of a man's digestive apparatus, the amount of cloth he uses increases with his purchasing power.

This is an industry which affects every class of people. It furnishes employment for men, women and children, who in turn absorb its product. No other industry can have a greater interest for the mass of the people, and the development of no other can therefore affect them to the same extent.

GREEK SPINNER TWO THOUSAND YEARS AGO.

When a spindle was first used for spinning is unknown, but the spindle and distaff are mentioned in the earliest references to mechanical art. The distaff was simply a short stick, on one end of which the raw material was placed, while the other was held under the arm, thus leaving the hands at liberty, one to draw the material and the other to manage the spindle. The spindle was a stick, perhaps a foot in length, having a slit or catch in the top, and a whirl of wood or metal at its lower end. The yarn being

held by the slit, the spindle, suspended in the air by the yarn, was rotated by the right hand to put in the twist, the yarn being wound upon it as fast as a length was spun.

The first improvement on the spindle and distaff was the invention of the spinning-wheel, about three hundred and fifty years ago. About the time of Henry VIII., it was used in almost every household in England. Every young woman, whatever her position in life, was taught to spin with this machine; hence the origin of the term "spinster," as applied to an unmarried female.

GREEK SPINNER OF THE PRESENT TIME.
(*From Life.*)

The spinning-wheel was simply a horizontal spindle, rotated by a band from a large hand wheel, the yarn being drawn through the fingers of the operator, as before.

A hand spinner with a spinning-wheel was said by Mr. Chauncy Smith, in his "Influence of Inventions on Civilization," to be able to spin a single thread about four miles

long per day, or eight skeins. Calling a day twelve hours, each spindle in a Rabbeth frame on 30s yarn would spin about the same amount, and, if the yarn were coarser, more.

This amount of yarn is spun now for one and one-tenth cents per week, for labor. Even the Hindoo spinner, at five cents a day, would make the labor cost thirty times as much with the spinning-wheel as it costs in one of our

NEW ENGLAND SPINNING-WHEEL.

modern frames, at the rate of wages paid in American factories. One spinner, tending a thousand spindles a day, does the work of a thousand spinners, with the old-fashioned spinning-wheels, not much more than a century ago.

In 1767 James Hargraves invented the spinning jenny, which was practically the application of the spinning-wheel principle to a number of spindles, together with a reciprocating motion of the spindles to and from the point where

the material is delivered, as in the mules of the present day. This spinning, as in the mule of to-day, was intermittent, rather than continuous.

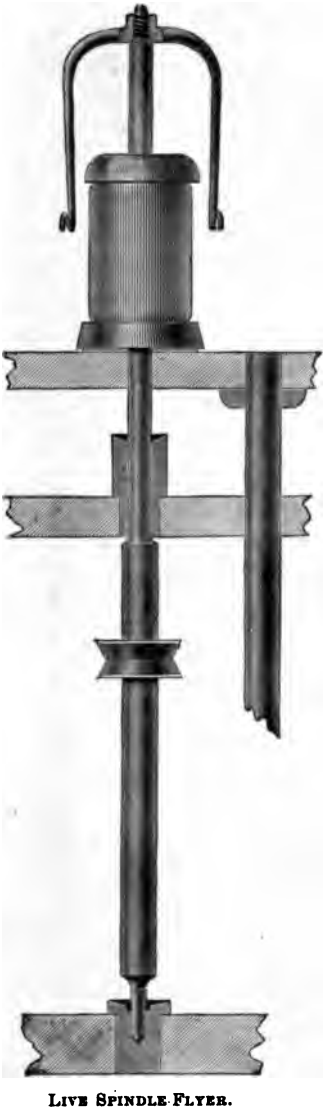
In 1769 Richard Arkwright invented the first continuous power spinning machine, which was intended, as stated in his specification, "to receive its motion from a horse." This was a flyer structure, on the general principle which has continued in use for nearly a hundred years. It is in use to-day to a limited and constantly diminishing extent.

These machines were received with great disfavor by the people, who thought they saw their occupation gone, if one spinner could do the work of a large number; and at one time preconcerted mobs broke up all the spinning machines in Leicester having more than twenty spindles each. No more absurd illustration could be given of the foolishness of the opposition of labor organizations to labor-saving improvements. The demand for labor has probably been as much increased by the invention of the "spinning jenny" as the cost of cloth has been diminished by it.

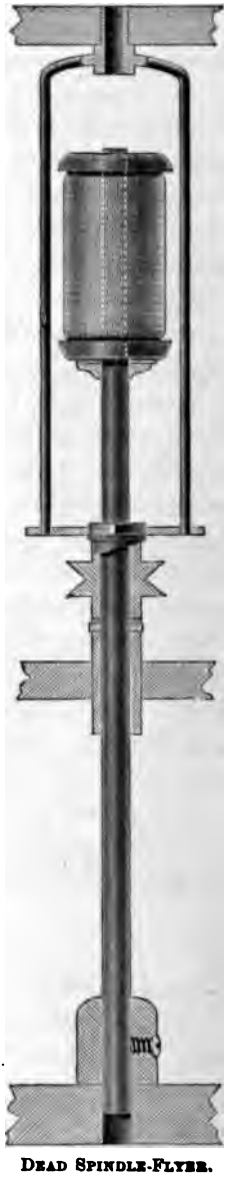
The Arkwright machine was called the "water frame," from the fact that, although the first ones were driven by horse-power, it was later on driven by water power. This machine was gradually perfected, and became known as the "throstle" or "flyer frame." It underwent various modifications, and became the standard machine for spinning warp all over the world.

In this machine, the sliver, passing from the drawing rolls to the bobbin, passed around the arm of a flyer, which was revolved some three or four thousand times a minute, thus giving twist to the yarn. The bobbin received motion from the flyer through the yarn, and had a speed equal to that of the flyer, less the number of revolutions required to wind the spun yarn upon the bobbin. Inasmuch as the system of spinning with a flyer had been used with a form of hand wheel known as the "Saxony spinning-wheel," that does not constitute the chief element of Arkwright's invention. He in this machine first introduced the syste

of drawing the fibre by rolls driven at different speeds, which is the universal custom at the present day.



LIVE SPINDLE-FLYER.



DEAD SPINDLE-FLYER.

Two kinds of flyer frames were in general use, — the live spindle-flyer and the dead spindle-flyer. The live spindle-flyer moved with the spindle, and the bobbin rested upon a drag carried by the traverse or copping rail. The dead spindle-flyer, an American invention, took its upper bearing in a plate above the spindles, and its lower bearing upon the dead spindle itself. The bobbin rested on a washer on the dead spindle, and revolved with it. The principle of spinning was the same. The yarn was wound upon the bobbin by the falling behind of the latter in speed, as compared to the speed of the flyer.

Danforth Cap Spindle.

The flyer frame made strong and satisfactory yarn; but, owing to the rapid revolutions of the flyers through the air, a great deal of power was consumed, and the speed was limited to about four thousand turns per minute, owing to the tendency of the flyers to spread. The dead spindle-flyer was the one most extensively adopted in this country.

In 1829 Mr. Danforth of Patterson, N. J., invented a remarkable spinning machine, known as the cap or Danforth frame. The flyer, which had been thought a necessity, was dispensed with entirely.

A dead spindle was fitted in the rail, carrying on its top a hollow cup. On this spindle a cast-iron tube with a whirl at the bottom took its bearings, and the bobbin was fitted to that tube. The bobbin had a reciprocating motion, to wind the yarn in suitable layers. The rapid motion of the yarn through the atmosphere served as the drag, and the

bottom edge of the cap fixed the vertical position of the yarn when wound.

This machine produced yarn very rapidly, as compared to the flyer, and more rapidly than the ordinary ring frame which succeeded it. It was necessary to run it rapidly, in order to obtain a proper drag upon the yarn. The objection to its general adoption was the imperfect character of the yarn, which was uneven, and in other respects less satisfactory than the "throstle" yarn.

Ring Frames.

In the year 1828 the first patent that I can find on a ring spinning frame was issued to Mr. John Thorpe of Providence, R. I.

I will make a digression here. Mr. Sawyer, president of the Chicopee Manufacturing Company, told me two or three days ago that he had had brought to him within about ten days, by a gentleman across the water, what this man thought was a great invention, and carried to Mr. Sawyer, as an inventor, to see what he thought of it. He produced his sketch of this great invention, but it was an indentical reproduction of the John Thorpe invention, with the peculiar ring which Mr. Thorpe introduced in his patent in 1828. Mr. Thorpe happened to have this paper, and he brought it out and showed it to the gentleman, and he went no further.

A few years later, patents on ring frames were issued to Mr. Samuel Brooks of Baltimore, Md., and to Mr. Geo. H. Dodge of Attleborough, Mass.

Evan Leigh, in his "Modern Cotton Spinning," says that ring spinning was said to have been invented by Mr. Jenks of Pawtucket, R. I. There seems to be no certainty on this point; but whoever the inventor was, he certainly has conferred a great benefit upon the human race.

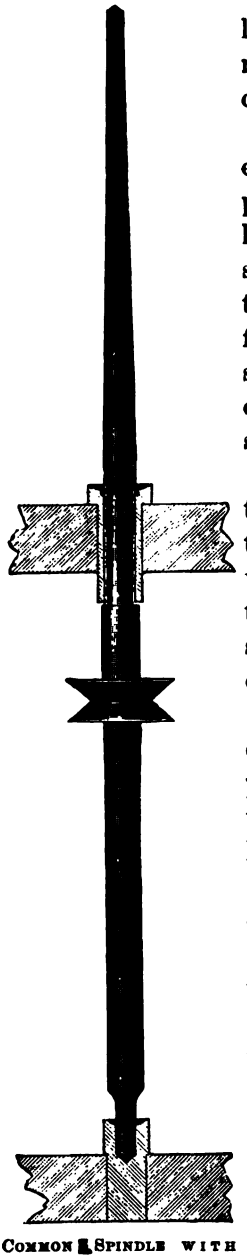
In the ring spinning frame the flyer is dispensed with, and the bobbin is carried with the spindle, and at the same speed. On the traverse rail is fastened a flanged ring, which is made as hard and as smooth and as nearly round

as possible. On this ring is sprung a small piece of steel wire, bent in a half circular form with the ends turned in, called a "traveller." The yarn, in going from the rolls to the bobbin, passes through this traveller; and the drag, or winding on, is obtained by the falling behind of the traveller in speed, as compared with the speed of the spindle and the bobbin. Different travellers are used for different sizes of yarn, and the yarn may be wound more or less compactly upon the bobbin by varying the weight of this traveller, and thus increasing the drag and the friction on the ring. The ring and traveller have a reciprocal vertical motion, and wind the yarn as fast as it is spun in layers upon the bobbin. The revolution of the spindle gives motion to the thread attached to the bobbin, and through that to the traveller.

The speed of the spindle and bobbin is greater than the speed of the traveller, by the number of times that the yarn is wound around the bobbin. The amount of twist in the yarn is equal to the number of revolutions of the traveller, while a given length is being spun.

By doing away with the flyer, the power required to drive the machine was greatly reduced, and the speed increased, so that the frame as a whole was much more effective. It was rapidly introduced in America, until in 1860 the larger number of spinning frames in use were ring frames. The flyer was still

Common Spindle with Positive Drive for Bobbin.



COMMON SPINDLE WITH TAPER SEAT FOR BOBBIN.

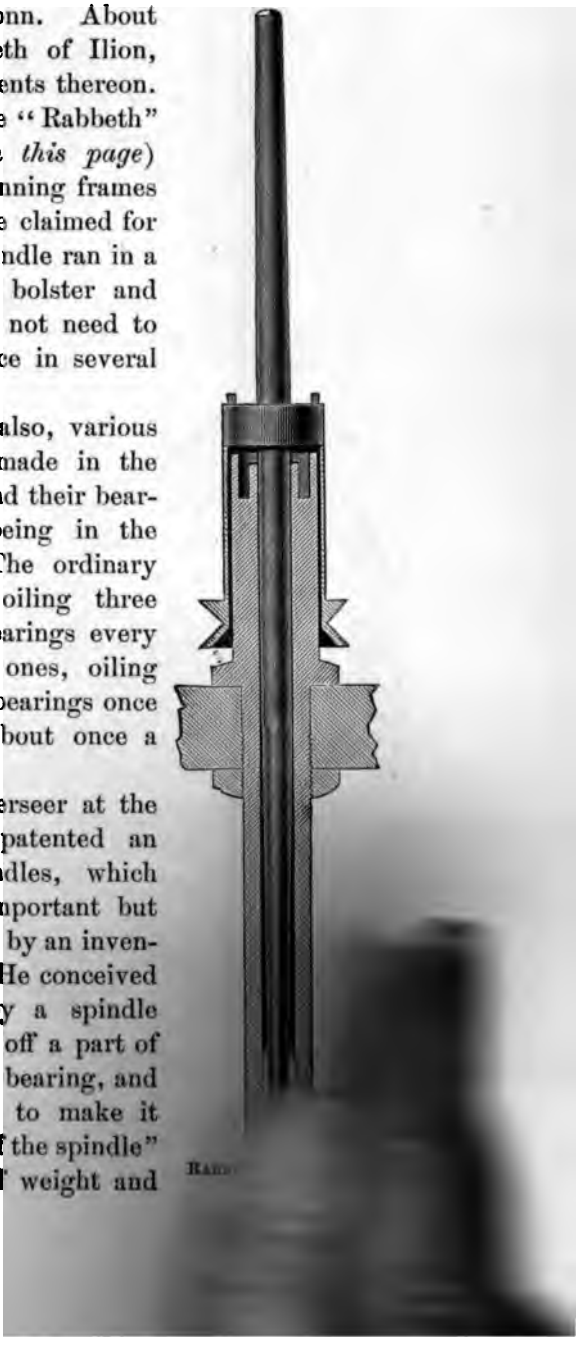
largely run on coarse work, and some mills were equipped with the Danforth or cap frames.

Manufacturers were divided in preference between what was known as a positive drive spindle, which carried a loosely fitted bobbin by a pin; and the spindle with taper blade, which carried the bobbin by frictional contact. Each form had its advantages; but the tapering spindle, carrying the bobbin by frictional contact, became, ten years later, the standard structure.

At this time the ordinary weight of the spindle varied from twelve to sixteen ounces, and the most rapid speed was five thousand five hundred revolutions per minute. At this speed, from seventy to a hundred spindles were ordinarily run by one horse-power.

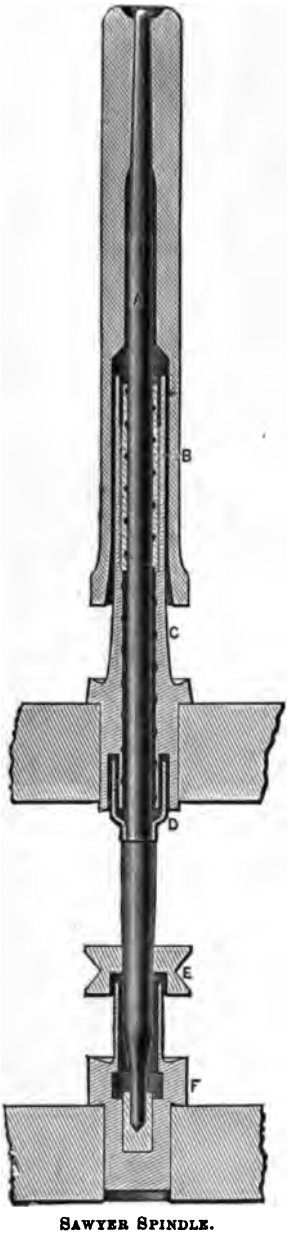
During these ten years successful efforts were made by various builders, particularly by Mr. John C. Whitin of the Whitin Machine Works, and Messrs. Fales & Jenks of Pawtucket, R. I., to reduce the weight of the spindle, and consequently the power required to drive it. The spindles were reduced in weight to eight, and in a few cases even to six, ounces, with some saving of power; but the speed could not be increased, as the lighter spindles sprung more than the heavier ones before used, and were more likely to throw off bobbins in spinning. The twelve-ounce common spindle was the best of that type for durability and steadiness of running.

The sleeve whirl surrounding the bolster bearing was during this period applied to ring spindles by Mr. John E. Atwood of Stonington, Conn. About 1866 Mr. Francis J. Rabbeth of Ilion, N. Y., made some improvements thereon. Quite a large number of these "Rabbeth" spindles (*see illustration on this page*) were put into use in both spinning frames and twisters. The advantage claimed for this device was, that the spindle ran in a tube which contained both bolster and step bearings. The oil did not need to be replaced oftener than once in several months.



During these ten years, also, various minor improvements were made in the common forms of spindles and their bearings, the principal ones being in the methods of lubrication. The ordinary bolster bearings required oiling three times a day, and the step bearings every day. With the improved ones, oiling was necessary at the bolster bearings once a week, and at the step about once a month.

In 1870 Oliver Pearl, overseer at the Atlantic Mills, Lawrence, patented an improvement in ring spindles, which might have been deemed important but for its being quickly followed by an invention of much greater value. He conceived that the power required by a spindle could be reduced by cutting off a part of the spindle above the bolster bearing, and chambering out the bobbin to make it lighter, while "the balance of the spindle" was preserved by cutting off weight and



SAWYER SPINDLE.

length from its lower end. This shortening of the lower end of the spindle brought the bearings closer together, and enabled a spindle of less diameter at the bearings to be used, and thus a substantial amount of power was saved.

The fact that the distance from the top of the bolster bearing to the top of the bobbin remained the same as before, prevented a great increase in speed, as an unbalanced load, such as is common in spinning, caused undue vibration of the bobbin, especially at its upper end.

Hundreds of thousands of spindles of this form went into use, but they have all or nearly all been replaced by later forms. In the number of Pearl spindles above referred to, I include what are known as the Birkenhead, which embraced the Pearl principle in part, and also the Sawyer principle, which I am about to decribe, in part.

In 1871 an invention in spindles was patented by Mr. Jacob H. Sawyer, then agent of the Appleton Mills, at Lowell, which entirely revolutionized spinning, and was one of the most important inventions of the time.

He conceived the idea of chambering out the bottom of the bobbin, and carrying the bolster up inside, thus supporting the load which the spindle had to carry near its centre.

The idea of an elevated bolster was not a new one on flyer frames, where the bobbin was loosely fitted on the spindle, and moved independently of it; but it was new in connection with ring frames, where the bobbin and spindle moved together. This change in support of the spindle enabled it to be greatly reduced both in weight and diameter of bearings, and the saving in power was enormous. The steadiness of running was also materially increased by the location of the upper bearing, and this enabled the speed of rotation to be increased also.

As the speed which the spindle would bear was at this time the limit of the production of the frame, an increase in capacity for speed in the spindle meant a corresponding increase in the production of the machine.

While with the common ring spindle the speed was limited to about five thousand five hundred turns a minute, with the Sawyer spindle it was raised to seven thousand five hundred turns per minute. At the same time a horse-power would drive about one hundred and twenty-five Sawyer spindles at the higher speed, while it would drive only about one hundred common spindles at the lower speed.

This increase in production and saving in power, together with many other incidental advantages, caused the very rapid introduction of these machines. Over three million were sold in the ten years succeeding their invention, when this spindle was superseded by one of even greater capacity.

During these ten years the Sawyer spindle underwent considerable modification and improvement. The first ones made required the removal of the bobbin to oil the bolster bearing. An ingenious invention of the late George Draper overcame this difficulty.

The first of these spindles were also made too light, and their bearings were imperfect in construction. Mr. George Draper, and others connected with him, corrected the faults one by one, until the Sawyer spindle in the latter years of its extensive sale seemed to have reached mechanical perfec-

tion. It was far better calculated for rapid revolution than any other spinning structure ever made, having rigid bearings.

RABBETH-SAWYER.

Soon after the introduction of the Sawyer spindle, Mr. George Draper and Mr. F. J. Rabbeth, before mentioned, about the same time, but independently, applied the Sawyer

principle to the Rabbeth form of spindle, thus greatly improving it.

Messrs. Fales & Jenks, together with Mr. Rabbeth, who was then engaged with them, commenced the manufacture of this spindle, and sold exceeding a quarter of a million of them in this country. Doubtless they would have sold more of them, but for the litigation between them and the owners of the Sawyer spindle, which was decided in favor of the Sawyer Spindle Co. This spindle was introduced in England to a greater extent than the Sawyer spindle, and millions of them have been put in use there and on the continent. The spindle was christened, by Mr. Rabbeth or Fales & Jenks, the "Rabbeth new model" spindle, and has since been called the "Rabbeth-Sawyer" spindle.

The sleeve whirl of the original Rabbeth was in the new spindle made so small that the bobbin could extend down over it and take its bearing on it, while the bolster was carried up within both sleeve and bobbin, thus supporting the load near its centre, as in the Sawyer spindle.

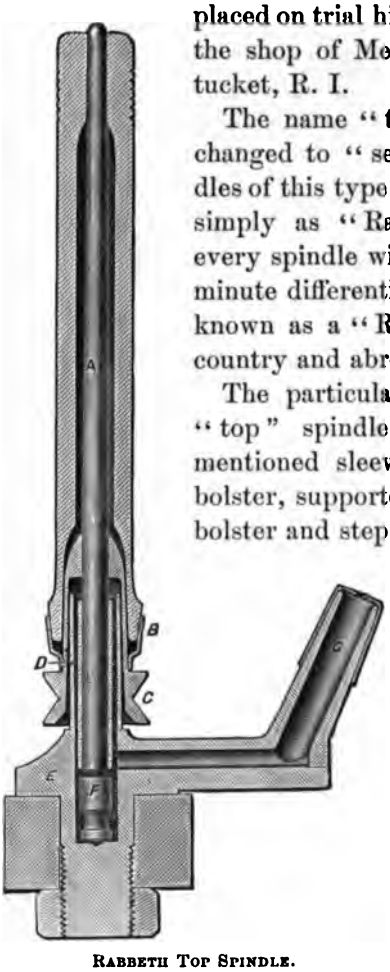
The bolster and step bearings were in the same tube, and oiling was required only about four times a year. This spindle would bear substantially the same speed as the Sawyer, but was found, in Geo. Draper & Sons' experiments, to require somewhat more power.

After the court decision against the Rabbeth-Sawyer spindle, Mr. Rabbeth turned his attention to experiments in a new direction, namely, the running of spindles in loose or yielding bearings. This was not new in itself, as experiments had been tried in that direction before, but without practical success.

The Excelsior spindle of Messrs. Jencks & Garsed of Philadelphia was the most successful of these experiments. Many thousands of Excelsior spindles were put into use, but they have been largely if not entirely replaced since. For some reason, loose or cushioned bearings do not seem to be practical in structures where the spindle bearings are held in separate rails.

In applying the principle of the loose bearings, however, to the Rabbeth sleeve whirl spindle, a great stride was made in advance, greater even than in the invention of the Sawyer spindle.

In the year 1878, after long experimenting, Mr. Rabbeth placed on trial his so-called "top" spindle in the shop of Messrs. Fales & Jenks of Pawtucket, R. I.



RABBETH TOP SPINDLE.

The name "top spindle" was afterwards changed to "self-centring" spindle. Spindles of this type have since come to be known simply as "Rabbeth" spindles, although every spindle with a sleeve whirl, before the minute differentiation of modern types, was known as a "Rabbeth" spindle both in this country and abroad.

The particular features of this so-called "top" spindle were: First, the above-mentioned sleeve whirl; second, the loose bolster, supported in a tube which held both bolster and step bearings, and formed an oil reservoir to lubricate them; third, the elastic packing ordinarily composed of woollen yarn which surrounded this bolster shown in the cut at D; fourth, the flat top step, on, rather than in, which the rounded bottom of the spindle moved with the bolster; fifth, the snout oil chamber, which insures a better supply of oil, and keeps the reserve at a higher level, than any other form yet tested. This feature had been before embodied in the Rabbeth-Sawyer spindle.

The spindle was called the "top" or "self-centring"

spindle, on the theory that the spindle acted like a top, and found its centre of rotation under an unbalanced load. This theory has since been discarded by experts, it now being thought that the advantages of the Rabbeth spindle are derived, first, from the cushioning effect of the loose bearing; and second, from the additional cushioning effect of the packing interposed between the bolster bearing and the surrounding case, both taken in connection with a sleeve whirl surrounding the tube containing the bearings. The spindle does not centre itself, but runs out of centre with less jar and vibration and heat, and thus is enabled to bear a greatly increased speed, and to run with less power.

Birkenhead Spindle.

About the time of the invention of the Rabbeth spindle other inventors produced different structures in a similar line. John Birkenhead of Mansfield, Mass., in fact preceded Rabbeth in making a structure having a yielding bolster in combination with a sleeve whirl spindle.

The Birkenhead yielding bolster, however, was attached to a fixed step, and the opportunity for yielding was given by an elastic connection between the bolster and step. This type of spindle was somewhat used, and it went into considerable use in a form known as the "Eureka" spindle, patented by Chapman some years since. In that form the bolster was held rigidly, and the step allowed to yield by means of elastic connections between them. Experience has shown that this construction is less advantageous than a construction that has freedom at both bearings.

'ATWOOD SPINDLE.

SHERMAN SPINDLE.

A little after Rabbeth's invention, Mr. John E. Atwood of Stonington, Conn., made a sleeve whirl spindle in which the bolster and step were made in one piece, and attached "in a yielding manner" to the surrounding shell or bolster case. This structure has gone into use to an extent of hundreds of thousands in silk spinning, but not extensively in cotton spinning, because of the great liability of the spindle to stand out of the centre of the ring at some points of the traverse of the ring rail. In silk spinning there is no ring or ring rail, the process being entirely different from that necessary in spinning cotton. The silk is spun off the spindle and the cotton is wound upon it.

At the time of the Rabbeth experiments, Mr. Albert R. Sherman was employed as draftsman and engineer in the shop of Messrs. Fales & Jenks, where most of these experiments were tried. He was of opinion that the packing between the bolster and supporting tube of the Rabbeth spindle was objectionable, and liable to need frequent replacement.

As early as the fall of 1878 he made spindle structures in which the packing was omitted. The bolster and step were made in one piece, and loosely fitted, while the supporting tube, unlike the supporting tube of Atwood's, was closed at the bottom and formed an oil reservoir. Unlike both Rabbeth and Atwood, he used no packing or spring connection between the bearings and the case that held them, but the oil in the supporting tube was supposed to act as a cushion between the combined bolster and step and the surrounding case during the vibrations of the spindle.

Opposite the band pull, the outer surface of the bolster was made cylindrical, and the inside of the supporting t in the same plane was made cylindrical also, tho slightly larger diameter, so that the band p tend to deflect the spindle from the perpendicu

Mr. Sherman, also by a positive lock prevented the revolution of his bolster wit

The Sherman experiments continued u

of 1880, when an entire frame was put in operation. From that time the sale was rapid, and the Sherman spindle is one of the standard spindles of to-day, several hundred thousand of them being in use. The spindle is clearly within the Rabbeth principle, though it differs from the Rabbeth spindle, as known in the trade, in several details of construction. Another experimenter in sleeve whirl spindles, closely following Rabbeth in the year 1878 or early in 1879, was Mr. Thomas Mayor of Providence, R. I. Mr. Mayor had previously been an inventor in both the fly and ring frame spindles, and it was claimed that he had used an elevated bolster on ring frames prior to Mr. Sawyer's invention. His idea on the sleeve whirl spindle was a very ingenious one, and capable of practical use, though it has not been adopted to any great extent, because the owners of his patents were also the owners of the Rabbeth spindle, and preferred the latter. He made a combined bolster and step, having a swell on its outer surface, which fitted into a socket in the supporting tube, forming a kind of ball and socket joint. The band groove of the sleeve whirl surrounding the supporting tube and its bearings was located substantially in the horizontal plane of this ball, so that the pull of the band had little or no effect upon the perpendicular position of the spindle. In case of an unbalanced load upon the spindle, the structure allowed it to gyrate with this ball as a fulcrum. A little later, Mr. Mayor

MAYOR SPINDLE.

placed springs or packing opposite the upper or lower ends of this combined bolster and step, so that, during gyration, there was a constant tendency to press the spindle back to a perpendicular position.

There have been several patented modifications of the Mayor principle, but, like the original, none of them have been adopted to any great extent. Mr. C. D. McDuffie, of the Manchester Mills, has been recently experimenting in this direction, and reports considerable success. As before stated, the Rabbeth top spindle was a great step in advance in the art of spinning, even over Sawyer's.

The Sawyer spindle was limited in speed. With an unbalanced load it would vibrate and gyrate, at more than seven thousand five hundred turns per minute, so as to become useless. The Rabbeth spindle, on the contrary, will bear any speed desired, and the limit of production of the frame is transferred from the speed that the spindles will bear, to the speed with which operatives can make good piecings of yarn broken in the operation of spinning. And I might add, on fine numbers the difficulty with which travellers are attached to the rings, and with the very finest numbers the difficulty in getting a traveller of the desired weight and shape, — so that at the Willimantic Woollen Mills they produce yarns at the highest speed at which they run. From nine to ten thousand revolutions per minute is the speed at which they are customarily run on medium yarns.

The power required to drive them at a speed of nine thousand does not exceed the power required to drive the common spindle at a speed of five thousand five hundred.

Returning to Rabbeth's early experiments, the first fe spindles tested in the shop of Messrs. Fales & Jenl attracted more attention, and deservedly, than any oth invention in cotton manufacturing during the present gene tion. The spindles were found capable of unlimited sp and capable of carrying absurdly unbalanced loads, or the tests made for visitors being the running of a b

stick as a bobbin on the spindle, at a speed of fifteen or twenty thousand revolutions per minute, which was accomplished with reasonable steadiness. Orders poured in rapidly from these exhibits; and, the facilities of Messrs. Fales & Jenks' extensive works not being sufficient to supply the demand, those of Geo. Draper & Sons, at Hopedale, were also brought into requisition, and taxed to the utmost. The "ne plus ultra" of spindles seemed to be reached.

ALLEN SPINDLE.

Practical running, however, developed incidental troubles. The packing, being continually beat upon by the bolster as the spindle vibrated, became thin, and in some cases torn in two; and under these circumstances the bolster was rapidly worn out. At other times the packing was insufficient to keep the bearings from revolution, and in that case the spindle gyrated and became inefficient. About the year 1881, the Rev. George H. Allen of Ayer, Mass., in experimenting to overcome these difficulties, adopted positive stops to prevent the rotation of both the bolster and the step of the Rabbeth spindle. He also omitted the packing, and made the step loose within the bolster, and extended the spindle into the step instead of having it move on the step, as in the regular Rabbeth structure.

The Allen invention was an important one, and has been partially adopted in all the Rabbeth spindles since made. It has also gone into use as modified by Messrs. Butrick & Flanders of Holyoke, and James H. McMullan, agent of the

Saco Water Power Machine Shop, at Biddeford, Me. This spindle is now the standard spindle built by that corporation. Mr. Allen sold his patents to the proprietors of the

RABBETH AS MODIFIED BY DRAPER AND KILBURN.

Rabbeth spindle, and his principle was applied to that spindle in a manner patented by John Kilburn, Esq., agent of the Lawrence Manufacturing Company at Lowell. This made

substantial improvement in detail in the Rabbeth spindle, by lessening the wear of packing, and obviating the need of frequent replacement of parts. In the latter part of 1883, an improvement was made by William F. Draper, the author of this paper, which still further lessened the wear of packing, and reduced to a minimum the one remaining objection made by spinners; namely, that a tight band, by compressing the packing, would draw the spindle out of the centre of the spinning ring, and thus affect the quality of the yarn and increase its breakage in spinning. By this improvement, the bolster was provided at its upper end with a head which nearly fitted the case, and at its lower end the motion was limited by an extension of the step within it. By this arrangement, the amount of compression of the packing could be regulated, and the lateral movement of the spindle and bolster brought to the lowest terms necessary for steadiness in running.

Somewhat later Mr. George Draper made the bearing of the spindle tapering, for the purpose of saving power. This Rabbeth spindle, so modified, was known in the trade as the "Rabbeth D 49," and was the standard spindle for three years. More than a million of them are in use.

During this time it was discovered by the Messrs. Draper that absolute steadiness could not be obtained without regulating the looseness in the bolster itself, that is, between the revolving spindle and its bearings. To accomplish this, Messrs. William F. and G. A. Draper experimented, and the results of their several experiments were patented in March, 1888. The spindle being tapering, and its bearing also tapering, it was evident that the looseness of fit could be regulated by raising or lowering the spindle or bolster, and that a mechanical arrangement for accomplishing this to the extent desired would enable the fit to be controlled. This they accomplished by making an external screw thread on the top of the step, and a corresponding internal one in the lower end of the bolster. The engagement was loose, so as to permit the lateral movement of the bolster, independent

of the step, as in the original Rabbeth. A turn or partial turn of the bolster raised or lowered it, and slots or notches

RABBETH "49 D."

in the bolster and step, and locking pins in the c
both in an adjusted position when the proper fit w

This form of spindle was the standard till the spring of 1888, when it was decided to lengthen the spindle and its bolster, to give a greater length of bearing.

WHITIN SPINDLE.

No substantial changes have been made since that time, and the operation of the spindle is so near absolute perfection that it would seem as though none were required.

I have omitted to mention another invention which has been used from the first on the Rabbeth and Sherman spindles, made by William T. Carroll of Worcester. On tapering spindles, prior to his invention, the bobbin was driven by the frictional contact of its bore with the outer surface of the spindle. With this arrangement the bobbins always stood at varying heights on the spindle, and were liable to be split. Carroll applied a cup to the spindle, which embraced the bottom of the bobbin, and drove it by external rather than by internal friction, thus obviating the difficulties mentioned.

Going back again, and referring to the "Sherman spindle," a modification was made in it about 1879, experimentally, by Mr. G. E. Tatt, superintendent of the Whitin Machine Works, at Whitinsville, Mass. This modification was perfected and introduced in 1883, and has since been largely sold under the name of the "Whitin gravity" spindle. The main difference between this and the Sherman is as follows: Sherman's bolster is loosely fitted in the supporting tube, while Whitin's has, or is supposed to have, a sliding fit in its supporting tube, without lateral motion, opposite the bolster bearing. There are some other differences in detail between the two structures.

Nearly or quite a million of these spindles have been sold, as the Whitin Machine Works have built nothing else in their frames for five or six years, and they have been to some extent applied to old frames.

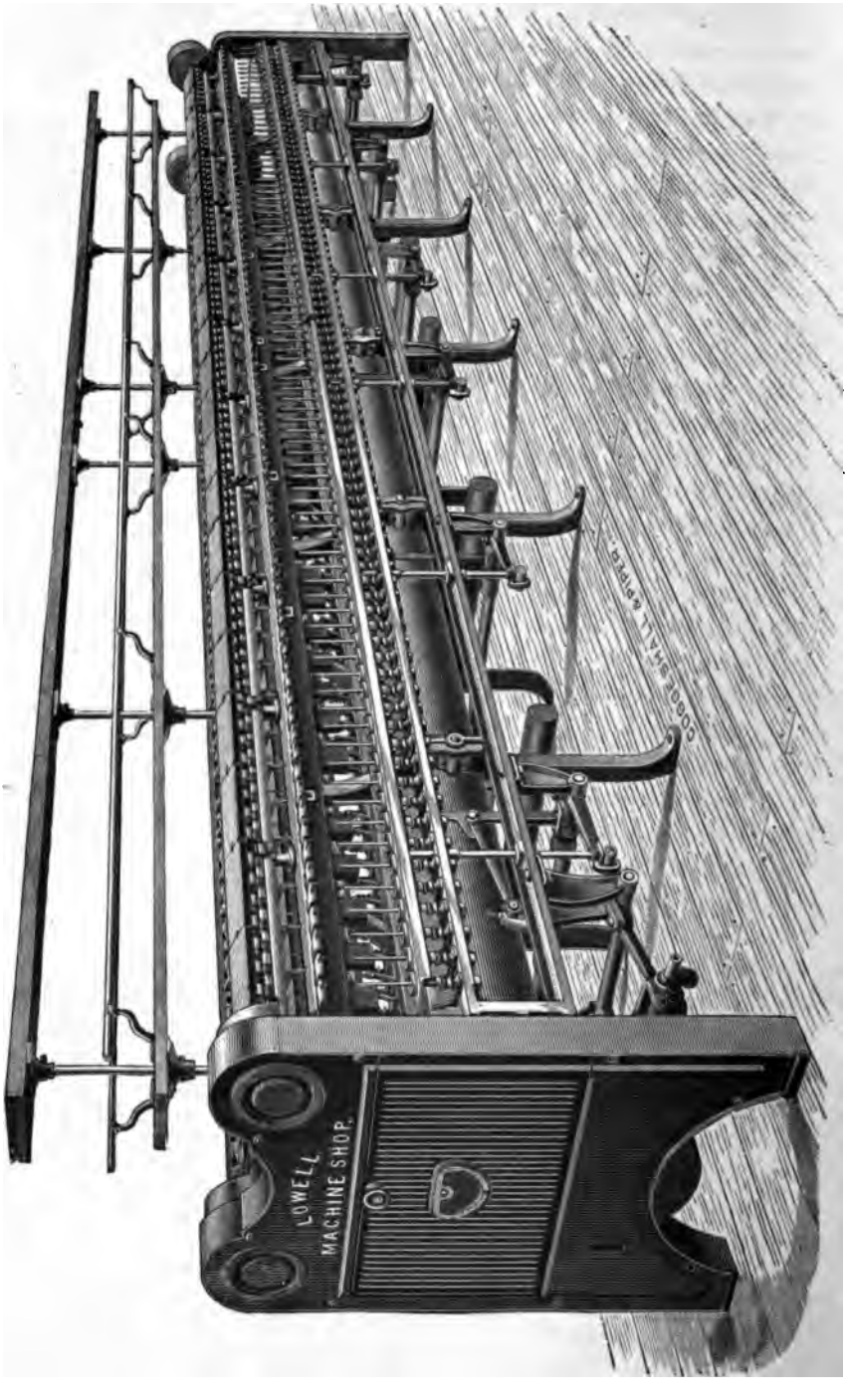
The Rabbeth spindle, in some of its forms before mentioned, may be said to be universally adopted. All new mills are equipped with it, and old ones unfortunate enough to be without it are changing as rapidly as their circumstances permit.

Manufacturers having the Sawyer spindle cannot compete on even terms, and the old spindle, known as the "common," is now most uncommon and substantially obsolete. Four forms of Rabbeth spindles are being made by American builders of ring frames at the present time. These are known as the Rabbeth proper or the No. 49D Rabbeth, the Sherman, the Whitin, and the McMullan. They all possess the characteristic features which permit the spindle to be run at high speed; namely, the sleeve whirl and the supporting tube within it, containing loose bearings, and serving as a reservoir for the oil to lubricate them.

The differences between these different types have been indicated in the preceding descriptions. The Rabbeth spindle proper is the one most largely built to-day, and the one that the writer believes to be the best of all the forms. Owing to its tapering bearing it requires less power, and owing to the packing it will run more steadily.

The feature of adjusting the fit of the spindle in the bolster I also consider of

McMullan Spindle.



Modern Ring Spinning Frame.

great importance, as affecting power, steadiness of running, and durability.

The McMullan type, by having its step and bolster made in separate pieces, has a double cushion, which those having the step and bolster made in the same piece do not possess. This feature tends to decrease the vibration of the spindle in running.

The Sherman and Whitin spindles have the merit of comparative simplicity, and are popular with spinners who object to the use of packing.

The number of spindles producing cotton yarn in this country, according to latest statistics obtainable, is about 14,550,000. As ring frames are universally used for warp yarn, and quite largely for filling, it is probably a safe estimate to call the number of ring frame spindles running eight million.

The number of Rabbeth spindles of all these forms in use Jan. 1, 1891, exceeds five million. These, with the three million Sawyer, would make the whole number in use eight million.

There are in scattered lots, especially in the South, a few old-fashioned spindles still running; but, on the other hand, some of the Sawyer frames have been changed to Rabbeth, so that the above estimate seems to be sustained by the number of these spindles sold.

The field for the Rabbeth in this country in the future is therefore substantially limited to the demand for additional spindles, and to the number required to replace the Sawyer.

The value of the introduction of these spindles to the community has been enormous. The figures below will show approximately this value, though they are believed to be low, as many incidental gains are not reckoned.

The average speed of common spindles before the invention of the Sawyer did not exceed 5,500 revolutions per minute. The average speed of the Sawyer spindle may be considered as 7,500, and that of the Rabbeth as 9,000.

The production of yarn is substantially in proportion

the speed of the spindle. We have found that the increase of production in altered frames was greater rather than less than the increase in speed, owing to the greater steadiness in running. On the basis of the speed, however, 5,000,000 Rabbeth spindles produce as much yarn as would more than 8,000,000 common; 3,000,000 Sawyer spindles produce as much yarn as would 4,000,000 common. It follows that, had the new spindles not been introduced, more than four million additional common spindles would have been required to produce the yarn now spun in this country.

The cost of spinning frames complete per spindle is about $3.

It is estimated that a square foot of floor space is required per spindle, to give suitable room for spinning frames and alleys. This costs at the lowest estimate 65 cents per square foot.

The necessary plant in and for shafting, heating, lighting, belting, etc., for this room would carry the cost for machinery and room above $4 per spindle.

At this figure, therefore, the saving in room, machinery, etc., has been 4,000,000 spindles at $4 each, or $16,000,000.

But this is not all. The old spindles, at 5,500 turns, required as much power as the modern spindles, either Sawyer or Rabbeth, at the higher speeds run; hence the power required to drive these 4,000,000 common spindles may be counted an entire saving. At 100 spindles to the horse-power, this would amount to a saving of 40,000 horse-power, or more than three water-powers like that of Lowell, and worth, at $30 per horse-power per annum (surely a low enough price for steam-power in New England), $1,200,000 each year.

Then, owing to the better running of these spindles, they require no more attention at their high speed than the common spindles at the low speed. The labor cost for spinning, including all employés, from the spinner to the overseer, is, in the best mills, about a cent and one-tenth per spindle per week, or fifty-seven cents a year. The labor saved per annum is, therefore, above $2,200,000.

Then, again, the old-fashioned spindles required oiling twice a day, while the Rabbeth requires oiling only once in three or four weeks, making a saving which would be counted a large benefit, were the other items not so enormous.

Capitalizing all these gains at ten times the annual saving and omitting the minor advantages, the advantage to the community by the introduction of the rapidly running spindles is shown by the following figures: —

Saving of machinery, ...	$16,000,000
Saving of power, ...	12,000,000
Saving of labor, ...	22,000,000
Making a total of, ...	$50,000,000

This is not all. The 3,000,000 Sawyer spindles will all, or nearly all, be changed to Rabbeth, while the remaining common and other inferior types of spindles must also be supplanted by the new types, and the gains from these changes, on the basis above stated, will be in the proportion above shown.

Still again: the hundreds of thousands of new spindles per annum required by the growth of the country are substantially all of the Rabbeth type. By making similar calculations to those above, the future value of these inventions to the public may be calculated in the same way.

So far we have only considered the advantage for this country. The Rabbeth spindle, in some of its varieties, is the only ring spindle now built abroad, and it has already gone into use there to the number of several millions.

There is no doubt in the mind of the writer that advantage to the human race from the invention an duction of these improvements in spindles has 1871 to date, more than $100,000,000, and th on increasing as the years go on.

The above calculations are submitted a and I shall be glad to consider any cri or upon any of my statements or conclu lations are correct, they show the gre

community from a series of inventions in only one of the mechanic arts during a short term of years.

Putting the calculation for this country in another light makes the result more striking than mere figures.

In 1870 there were less than seven million spindles in the country, not more than half of them on warp.

The saving effected by the new forms of spindle since that date has thus been more than all the warp spinning machinery then in the country, with the power required to drive it, the labor required to run it, and all the incidental expenses connected with it. This seems enormous, but it is nevertheless true. From this, also, it is easy to deduce another fact of interest to cotton manufacturers, — that to-day more than three times as much warp yarn is spun in the country as in 1870, a rate of increase without parallel since the earliest introduction of the cotton manufacture.

In closing, I take the liberty of pointing a moral or two deduced from the facts and figures before given.

But for the patent system of the United States, the advantages derived from these inventions would probably never have been realized.

The Rabbeth idea was developed under the pressure of patent litigation, and but for that it would never have been born.

More than this, if either the Sawyer or Rabbeth idea had been furnished gratis to any single cotton manufacturer, the gain in his establishment alone would not have warranted him in expending the large sums which were required to develop and perfect the structures. If given to a machine builder, he could not have afforded to expend these sums in the hopes of obtaining only a manufacturer's profit, in competition with any other builders who saw fit to copy his work.

This would apply to all improvements requiring a large amount of time and money to perfect them. Business men would not and could not give this time or spend this money, if, when the desired result was accomplished, no personal advantage could be secured thereby.

Another reflection seems pertinent: Bills have several times been brought before Congress to abolish all duties on cotton machinery, on the ground that it is a "raw material" of the cotton manufacturers, and that a lower cost for machinery would encourage the building of more cotton mills.

I presume there would be no question here, that, if cotton goods are entitled to tariff protection, machinery is also; but these inventions furnish such an illustration of the public value of home industries that I feel warranted in calling your attention to them in this connection.

The Sawyer spindle was invented by an American, and was perfected in an American machine shop. The same is true of the Rabbeth spindle, and the inventor was a mechanic employed in an American shop, engaged in building cotton machinery. The improvement was made upon a machine, the ring frame, that was in 1870 hardly known in England, and so far as known there it was unpopular, because English builders had not learned to build it properly.

Had there been no shops here making cotton machinery, it is very probable that our spinners generally would be using flyer frames to-day, and that not only the Sawyer and Rabbeth spindles, but the ring frame itself, would be still practically unknown among us.

Supposing, however, that the ordinary ring frame was in use here, and that all cotton machinery was imported without payment of duty, and that the extent of the cotton manufacture remained the same as now (which it would not); the saving made by American inventions in this single machine would exceed the whole amount of duties that would have been paid on all kinds of cotton machinery.

Our number of spindles has increased about 8,000,000 in twenty years. The cost in England of carding, spinning and weaving machinery, all included, on average counts is said not to exceed one pound or five dollars per spindle. This would mean an importation of $40,000,000 worth of machinery, English price. At 45 per cent., the present rate, the duty would be $18,000,000, — all the saving that

could have been made by free trade in all kinds of cotton machinery, if all were imported; while American invention, on only one of the many different machines required, has saved the country three times as much.

Besides this, we have had the advantages of protection; diversified industry, employment at good wages, increased market for other productions, and so on.

By following out this line of thought, and making fair investigation, I believe it would be found that American inventions in protected industries, made possible by their existence here, have been worth far more to the country than all the saving that could have been made in the cost of the articles under absolute free trade.

This, however, is a spindle rather than a tariff essay, and I hope that you have found sufficient practical advantage from it to repay you for your kind attention.

At the conclusion of the reading of the paper, General Draper continued: —

Gentlemen, I want to detain you long enough to read a letter which was received since this paper was written. It came without solicitation. In preparing a new book which we are about publishing, an advertising book, my son wrote to Mr. F. P. Sheldon of Providence, R. I., asking for estimates of power, etc., and he sent them up, and also sent this letter.

Providence, R. I., April 3, 1891.

George Draper & Sons.

Dear Sirs: In connection with the figures on Print mill, it occurred to me that you might be interested in the matter of power, as this item has increased so extremely since the days of Sawyer, warp and mule filling. I have made calculations based on above style of mill, and the *modern* high-speed Rabbeth, and all frames, and find that the *product* per horse-power is about the same in both, *i. e.*, the increased product from high speed just balances the increased power. (This is comparing with the *best* mules, high speed.) Of course, figures can be found in different mills, where

the speeds are either up or down a little, that would vary the above result, but for an average it is as near right as can be fixed upon.

The question of power has sometimes been raised, on account of the "new speeds," whether it does not take more power to *produce a pound of yarn* now, than with the moderate speeds of Sawyer and mule filling. It does not. The result is about the same in comparing a mill with Rabbeth high-speed warp, and best high-speed mule filling, with all frames. In other words, the *question of power* per pound of product seems to be practically without weight in any comparisons of this sort; and this leaves the comparative merits to be settled on other points: cost of labor, floor space, machinery, etc. Yours truly,

F. P. SHELDON.

The committee on nominations reported the following nominations for officers of the Association for the ensuing year, and, on motion, the Secretary cast the ballot of the Association for the nominees, who were thereupon declared elected: —

President, WALTER E. PARKER of Lawrence, Mass.

Vice-Presidents, ROBERT MCARTHUR of Biddeford, Me.; SIMEON B. CHASE of Fall River, Mass.

Directors, E. W. THOMAS of Lowell, Mass.; WILLIAM H. WHITIN of Whitinsville, Mass.; ROBERT R. SMITH of New Hartford, Conn.; ALFRED M. GOODALE of Waltham, Mass.; WILLIAM J. KENT of New Bedford, Mass.; and HERMAN F. STRAW of Manchester, N. H.

The Secretary here read the following nominations for membership in the Association; the several gentlemen being recommended by the Board of Government for election: —

Messrs. SAMUEL HALE, South Berwick, Me.; JOHN K. RUSSELL, Grosvenor Dale, Conn.; EDWIN N. BARTLETT, North Oxford Mass.; FREDERICK A. FLATHER, Newton Upper Falls, Mass.,

who were thereupon elected members of the Associatio

The PRESIDENT. Discussion of the paper by Mr. Draper is now in order.

Mr. ATKINSON. Mr. President and Gentlemen: When the Columbian Exposition was first proposed I ventured to make a suggestion to those who were the managers in New York, since transferred to Chicago, that it should be made an exhibition of the development of industry. I held to the theory then, now fully sustained, that whatever had been at any time in the history of the world, exists now, somewhere. I knew that by going to Patagonia and Alaska, one would discover flint implements still in use, corresponding to those used by the mound builders, that might be placed upon exhibition. I did not feel sure that the distaff would be found anywhere. I have since found it in use in different parts of the world. The first was in Mexico, and through the kindness of the late Mr. Wade I sent down to Mexico and procured this picture of the art of spinning with the distaff and weaving without a loom, as it is even now practised among the people of that country. I also procured from Greece this little picture, which I handed to General Draper to copy in his treatise. I have sent to Peru and to Pompeii, where the distaff is still used by the spinster. Singularly enough this led to the discovery of a curious type of art which one would hardly have thought to find in a country like Mexico, but there came up, by the kindness of the gentleman by whom my message was sent, a set of typical figures which I think are among the most extraordinary illustrations of an art that I have ever seen. They are not very fragile; they are rag dolls, and they represent the Mexican peon spinning cotton upon the distaff; the daughter combing her hair; and the old gentleman reading what is apparently an advertisement of a quack medicine.

I thought it would be of interest to you to see these photographs taken from the little figures; and then I thought it would be interesting to you and others to see some of the actual product of the distaff, and I sent again to Mexico and procured the wool which they are now using. You will

A Mexican Distaff Spinster and a Weaver.

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ASTOR, LENOX AND
TILDEN FOUNDATIONS.

A Mexican Woman Spinning Cotton upon a Distaff.

THE NEW YORK
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ASTOR, LENOX AND
TILDEN FOUNDATIONS.

bear in mind that this use of wool in Mexico is quite modern. When the Spaniards conquered Mexico the clothing of the people was wholly of cotton and feathers; wool was entirely unknown; but they are now preparing wool in a rough-and-ready way. This spindle has not the weight attached to it which the distaff usually has, but it was sent up as an example of the distaff without the weight. Here is the yarn, and here are two varieties of Mexican cloth which must correspond identically with the prehistoric types of cloth made by those who used the distaff on common wool. There may be more of these things which might be brought into that exhibition; the African loom, for instance, from Liberia, — a hand loom which is absolutely a hand loom. It is only a little frame, a few inches square, upon which the narrow web is woven, and those webs are afterwards stitched together. Again, the blankets of the Navajo Indians of California, the finest and most beautiful blankets in the world, are produced by hand. If that idea were adopted for the exhibition; were these people, and their dwelling-houses and their arts, exhibited at one end of the great building, it would lead to the finest example of the development of the Draper spindle and the modern spinning frame from the preceding arts that could possibly be produced. It would make an interesting exposition; with these modern types before us, we would see how much these pestilent inventors have deprived people of the privilege of working for their living, and working very hard.

The President. Is there anything more to be said upon the history of spindles? If not, we will proceed to the next paper upon the list.

Mr. E. S. Draper. Before that paper is called for I would like to offer the following motion: that the Board of Directors be authorized to lay an assessment on the members of the Association, not exceeding ten dollars, to defray the expenses of the ensuing year.

The motion was seconded and adopted.

The PRESIDENT. I now have the pleasure of introducing to you Mr. CHARLES H. FISH of Manchester, N. H., who will present a paper on the use of "Oil Fuel under Boilers."

Mr. FISH. Before beginning, let me say that this subject is so immense, so extensive, that in this limited time I will have to let details alone and only treat it in a general way.

OIL FUEL UNDER BOILERS.

By Charles H. Fish, Manchester, N. H.

Of the great problems which to-day interest the manufacturers of New England, there is, perhaps, not one of more importance and therefore none to the solution of which we look with more interest than the question of cheap fuel for our boilers.

To be sure, coal in itself is a cheap fuel, as it is found at the mines; but situated as we are, away from the coal fields, we are completely at the mercy of the various railroads and water lines over which our coal must come; and adding to the expense which the different railroads must incur in transporting such bulk, the profit which each road or line claims as it in turn does its part, the expense at our yards for handling, we find our cheap coal at the mines, when dumped in front of our boilers, becomes the expensive fuel with which we are all familiar.

Coal is our present standard. It is in general use, and we are all familiar with its good qualities, as well as with its bad ones, but with the fuel in question, petroleum oil, it is different. Although oil has been used in one form or another for many years, and although much has been and is written on the subject, still, viewing it in its relation to its economical use under steam-boilers, it is comparatively new, especially in New England, and apparently but little understood outside of a few who have been led on by its possibilities, and have achieved more or less success in their attempts to obtain a safe and economical application for heat purposes.

Although, as I have said, the application of oil to steam-boilers is comparatively new in New England, at the same

time we are astonished at the multitude of burners and apparatus which have been put into other markets, the majority of which are absolutely worthless for practical use. I learn from the United States Patent Office that there have been over five hundred patents granted for oil burners of different kinds.

Oil as a fuel for any purpose has been but little used in New England, but the middle States are full of oil fires, good, bad and indifferent, with all sorts of applications, and we seldom, if ever, hear of any accident occurring to the boilers or employees on this account; neither do we hear of any trouble with the boilers from over-heating or other causes due to the heat.

With these many examples at hand where oil is used as a fuel, and on a large scale, where all nationalities and all grades of intellect are in direct charge of the same, where poor apparatus as well as good are in constant use, it seems as if the question dissolves itself into one of economy and reliability of apparatus.

We must consider briefly the different methods now in use, and in so doing it will be well to follow the classifications already established, namely, first, Oil or Hearth Fires; second, Spray Fires; third, Gas Fires.

Oil or Hearth Fires.

In this class are included all those methods in which the fuel is burned in liquid form. There are several kinds of hearth fires. Herr Busley subdivides this class into pan fires, step fires, drip fires and oozing fires.

The pan fire is the simplest form for burning oil. It consists of a pan or shallow bowl into which the oil runs, and is kept at a uniform depth. The oil is ignited by a torch and burns over the entire surface of the pan.

Step fires seem to follow naturally the pan fire, differing only in the fact that several pans are placed one over the other, like steps, and the oil overflowing from one to the other obtains slightly more oxygen than it does in the still pan.

Neither of these forms are to be considered safe, as there is considerable oil in the fire-box at one time, and the oil is fed to the pans by gravity. Perhaps it will be well to say that these forms are among the oldest, and would hardly be used in practice to-day.

In the drip fire system the oil is allowed to drip into the fire-box through numerous pipes with small openings, and in this way becomes more or less mixed with the air, which is forced through the openings in the grate bars.

Oozing fires. — Richardson's furnace and the Locke furnace are good examples of this class. The bottom of the fire-box, or in some cases the grate bars, are covered with some porous substance like sand or asbestos, and the oil is introduced from below, — the porous substance serving the same function as the wick to a lamp. In some cases, as in the Richardson furnace, combustion is aided by superheated steam.

Spray Fires.

Taking the next class, the spray fire, we find a large and varied family. The oldest form of spray fires I am told consisted of a narrow orifice, divided longitudinally by a thin partition, on one side of which was the oil and on the other side the steam. This form has from time to time been changed and improved upon, but we find to-day this very burner, in more or less modified forms, in many of the large establishments in the middle States and on the Continent.

The usual form consists of a small or inside pipe enclosed in a larger or outer one. The oil is forced through the inside and steam or air through the outside one, the oil being thus vaporized or sprayed. In some burners the steam is in the inside pipe and oil in the outside one. The effect is practically the same, although I believe more efficiency is claimed in the former case, the mixing being more perfect.

In the Cyclone burner the atomizing is effected by forcing the oil under pressure through a pipe containing a revolving screw. The oil issues in a finely divided condition and meets

a current of air also under pressure. The pressure is obtained usually by a small steam pump.

The Reid burner contains the same concentric pipes, but has an improvement attached by which the steam and air are admitted proportionately.

The Rockwell is another well-known burner or injector of this form using steam.

The Aerated Fuel Company's system consists of burning oil with compressed air. In applying this to horizontal boilers, holes are drilled through the front (usually each side of the door, much the same as in other systems, and above the grate bars, which are not removed), large enough to admit the end of the burner. The burner consists of a small cylinder placed with its axis horizontal and fitted with two inlets, one entering above the horizontal diameter for air and the other entering below for oil. To this cylinder are attached the burners proper. They consist of two concentric tubes, the inner tube being connected with the oil chamber and the outer tube opening into the air space.

The oil supply pipe extends nearly to the bottom of the tank. The air space is connected with the air pump. The pipe from the air pump also enters the top of the oil tank. By this arrangement the pressure of air from the pumps is exerted on the oil in the tank, while a like pressure forces the air through its orifice in the burner. The air mixes with and breaks up the oil, forcing it into the fire-box in a fine spray.

Gas Fires.

Under this head are classed those apparatus in which fuel is conducted to the fire-box in a gaseous state. Most of these devices generate the gas in the fire-box and by the heat of its own flame, and in so doing meet with one of the greatest obstacles which this class has had to contend with, namely, the stopping up of the pipes by the non-vaporizing of the residuals. These residuals when exposed to great heat coke or carbonize, completely filling up the pipes with a

substance as hard as flint and almost impossible to remove, and it is for this reason that the greater part of this class are worthless for practical use, although some of them may show a very fine fire for a few hours.

Many processes have been patented for the manufacture of this gas, and there are two or three which are operated with more or less success. One of the latest in the New England field, although used for some years in other parts of the country, is the Archer Gas Fuel Process, which is in practical use in one of our mills. In this process there is a form of apparatus called a producer, which generates the gas, and it is in this producer that the dissociation of steam for the production of hydrogen gas, and the volatilization and decomposition of liquid hydrocarbons are effected. It is a step-by-step process. The oil is forced through a small pipe to the producer, where the gas is made. Here it is passed through copper coils surrounded by superheated steam. Thus the heated oil with its vapors unites through an injector with highly superheated steam, and together enters the horizontal S-shaped vaporizers, where the free carbon of the oil seizes upon and unites with the oxygen of the steam, leaving a considerable percentage of free hydrogen which passes into a central cast steel retort and the gas let out through its top and piped to the boiler.

Let us now pass on to a comparison of the merits and demerits of the different systems. The uncertainty or difference of opinion among scientific men as to the most important feature, namely, the combustion itself, makes such a comparison more difficult than it would be otherwise. Again, if every user of oil or even a majority of users were surely informed as to the efficiency of their especial apparatus, we could by comparison of figures reach the desired results, the only unknown quantities remaining being the cost and care of apparatus and life of the same.

Now the facts of the case are that but a very small percentage of oil users have any definite idea as to what results they are obtaining, and I surely think that there is quite a

large percentage who have never given this question any serious thought. This, of course, is especially apparent throughout the central States, where oil is cheap and handy, and therefore the fuel account is of less importance than in New England.

I think until recently the opinion has prevailed, to a greater or less extent, that if we could find some safe method of burning oil the problem of cheap fuel would be solved in one short and easy lesson. Taking advantage of this fact, inventors with more imaginative than inventive minds have placed upon the market, from time to time, various apparatus, whose principal recommendations lay in the promises of the promoters before a trial and its rapid death soon after trial. Still, these impractical inventions have all had a tendency to shake the confidence of steam users, thereby rendering the introduction of oil fuel difficult.

Another element of uncertainty, and to me a most important one, is in the oil itself. There is no doubt that many apparatus with some merit have been abandoned on account of unsatisfactory results of a test in which the quality of the oil used played a most important part, while no doubt poor apparatus have been greatly aided in the same way.

With an experience covering eight months of constant testing on a battery of three one hundred and seventy horse-power boilers, I find that there is at least a difference of twenty per cent. in the efficiency of the oil, all supposed to be the same grade of crude. I do not say that we get this variation at all times, but occasionally, with the conditions exactly the same in the boiler room, you will find that you are by necessity consuming much more oil to obtain the usual results, while your fires show red, with more tendency to carbon. This trouble can no doubt be avoided to a great extent by the parties who ship the oil, and it would be well to bear this in mind when ordering.

To detect the objections to most forms of apparatus requires but a slight acquaintance with the subject, and a very limited knowledge of the principles of combustion.

No burner using oil in its natural state, or in bulk, we might say, can obtain as good results as when it is sprayed or gasified, simply from this fact, that it is impossible to introduce air sufficient for complete combustion at the right point. The simple introduction of air into the fire-box is not all that is needed. It must be introduced in such a way as to become thoroughly mixed with the flame during combustion. For this reason the first fires were very unsatisfactory, being smoky and red without much heat. Occasionally even now we hear of some one who is trying one of these types of oil fires, and I know of a mill which, within a few weeks after looking the ground over for the best thing, adopted for trial a modified form of pan fire, the pan being on the outside of the fire-box, and the oil allowed to drip inside, and, after enduring the odor of the warm oil for a week or two, discovered that the fuel account was growing visibly larger. Perhaps it is not strange that these gentlemen are now firm believers in "good old coal."

Allowing that the oil must be sprayed or atomized, which is the most desirable to spray with, air or steam? Here is a question the answer to which in my opinion must be looked for as much in practice and practical work as in theory.

There is certainly nothing hidden or uncertain in the burning of oil sprayed with air. The oil in its finely divided condition burns freely while combustion is aided by the access of oxygen, but when steam is introduced the effect is different.

Chemistry teaches that steam is decomposed at a high temperature, and in the decomposition hydrogen is liberated. This temperature is without doubt attained at times in the fire-box. We must, therefore, decompose the steam and liberate hydrogen. Now when hydrogen enters into chemical union with oxygen more heat is developed than in the burning of the same weight of any other substance. Stopping at this point we find that we have decomposed the steam, liberated hydrogen, and by burning have increased greatly the temperature of our fire, therefore increasing its efficiency.

This is a correct theory which you will hear advanced by those interested in steam injectors, or steam as against air burners. This, of course, although good theory is worthless in practice, as it costs as much to liberate hydrogen as you get from its combustion. Is there then any advantage in the use of steam over air? The best I can do is to use the old adage, "The proof of the pudding is in the eating;" and there is not the slightest doubt in my mind but that the steam injectors as a class are doing more satisfactory work under boilers than the air injectors. With the air injectors we get a short, sharp flame with rapid and perfect combustion, and particularly adapted to small fires and light work; with the steam injectors the combustion is much slower, and for this reason we get a longer, heavier flame and one better adapted to large furnaces and boiler work.

Among the oil regions of the Caspian, and throughout all Russia, the steam injector in some form or other is the only one in use, at least to any extent, and the same statement is true of this country. Travel where you will among our oil-burning communities and you will note the decided preference given to the steam burners, and the highest evaporation per pound of oil as far as I can learn has been reached with this same class.

With these observations it is natural and fair to suppose that there must be some practical advantage in the use of steam over air, whether by the decomposition of the steam or otherwise.

As you have probably discovered, the burner itself is the principal part of most of the apparatus adapted to use steam, and although they vary one from another in detail of construction or method of regulation, as a rule there is one simple principle displayed throughout them all, namely, the bringing together of the steam and oil through concentric pipes. I do not mean to make here any rash statements, but I do firmly believe that a burner can be made in your own shop which will answer the purpose as well as most of the burners in use, the expense of which will be the cost of two

short pieces of pipe, one common T and two three-quarter valves, with fifteen minutes' labor. I do not mean to say that this burner will be as attractive in appearance or as efficient as some, but the principle is there complete, without a royalty. We can scarcely read an item or opinion on oil as a fuel without finding some mention of the liability of trouble arising from the stopping up of the pipes or burners, and many there are to-day who are struggling with this difficulty; and the cause of the trouble is not always from the formation of coke or carbon, but from dirt, or foreign substances in the oil which are too large to pass through the necessarily small orifice in the burner. At times the scale which forms in the pipes breaks off and the flakes lodge in the burners. Of course the smaller the oil outlet and the dirtier the oil the more liable you are to trouble.

Another difficulty which is found with all steam burners is the necessary variation in the condition of the fire, due to the fluctuation of the steam pressure in the main. It is easily understood how, with the steam pressure at one hundred pounds, the velocity of the fire, and therefore the condition, varies greatly from steam at fifty pounds. This can be avoided by the use of a separate boiler, where the pressure can be easily controlled, or by the use of a pressure regulator, which I do not think would work well under such conditions.

It is possible to get a very unsatisfactory fire from the best of the steam injectors, and more care is necessary in the application to boilers than with the air injectors, on account of the liability of the condensation of the steam against cold surfaces before combustion takes place.

In the Archer Gas Fuel Process the gas is manufactured as fast as required and passed to the fire-box in pipes, no burners being used or contraction of the pipe in any way, therefore doing away entirely with the trouble from stoppages. The fires are extinguished by shutting off the supply of oil, thereby doing away with any accumulation of gas, while the

pressure is regulated entirely independent of boiler pressure. The superheating and dissociation of the steam requires heat in the producer, which can be furnished by its own gas.

That this apparatus is simple and reliable would appear from the fact that it has been in use in some of the best steel works in the country for over three years. With a personal experience of over eight months with this apparatus, I have never had any trouble with it in any way, although various men have had the care of it, not one of whom, myself included, had any experience with it before placing it in the mill.

The advantages which one apparatus may have over another in form, ease of handling, etc., must have their influence upon us. At the same time we must not be deceived by appearances, as the appearance of an oil fire is the most deceitful thing I know of, excepting, perhaps, some of the figures given out about it. We must look to actual results in everyday practice. I must acknowledge that I have been rather unsuccessful in my attempts to obtain reliable information and figures as to the special performances of the various kinds of apparatus which are in use. There are plenty of figures to be had, and most of them good figures too, but when followed up lack confirmation. Many of these figures purporting to be the results of tests are published purposely to deceive and thereby further some stock-jobbing scheme.

A test in one of our Ohio mills a short time since, giving an evaporation of twenty pounds of water, was published widely by the manufacturers of the burner used. I went some distance to see this plant and found that in connection with their boilers they were running a heating furnace, and from the same oil supply; and in figuring up the results of the test in which the water had all been carefully weighed they, the engineers, made a careful estimate with their eyes, and decided that the size of the flame in the furnace was about equal to the size of the flame in the fire-box, and there-

fore it must take as much oil. I simply cite this case to show how uncertain and how misleading many of these figures are.

In a little pamphlet published by the Standard Oil Company on "Oil as a Fuel," they say: "It has been demonstrated that one pound of oil will evaporate the water of more than two pounds of coal. The heat units of crude petroleum have been erroneously stated to be 27,531. The fact is that correct figures are 20,240 heat units, which have been repeatedly arrived at of late, after many tests with the best instruments to be obtained for that purpose.

"In comparing the calorific properties of petroleum, it must be borne in mind that with coal there is an enormous waste of matter, such as sulphur, slate and earthy substances, which is practically incombustible and which does not aid in the generation of heat. While coal contains about 14,300 heat units, that figure is by reason of these impurities reduced to about 8,000. Pure carbon, charcoal for instance, contains 14,500 heat units. Considering, therefore, the imperceptible waste in the burning of oil and the excessive waste in the burning of coal, the conclusion is reached that while theoretically the relative proportion of heat involved in the combustion of oil compared with coal is as $20\frac{2}{10}$ to $14\frac{3}{10}$, the proportion, practically considered, is in favor of oil as 19 to 8, or $8\frac{5}{10}$ at the farthest.

"We may quite safely assume then that the heating capacity of oil is considerably more than twice that of coal, as far as now shown. With a clean boiler properly attended to, and with the best coal fuel well stoked night and day, with every care to insure combustion and to avoid waste, an evaporation obtained in some isolated cases, specially recorded, has been as high as $9\frac{1}{2}$ pounds. In our every-day experience, however, we find that eight out of one hundred boilers will not vaporize more than from 7 to $7\frac{1}{2}$ pounds of water per pound of fuel.

"On the other hand, oil tests, which while sufficiently conclusive for the present have not by any means been

carried to the farthest limit, show a vaporization of from $17\frac{56}{100}$ to $18\frac{5}{10}$ pounds of water per pound of oil consumed, estimating feed water at 212° Fahr."

Dr. Charles B. Dudley, chemist for the Pennsylvania Railroad Company, in his lecture before the Franklin Institute of Jan. 6, 1888, said: "The following table shows a relative heat-producing power of coal and oil. In this table the following assumptions are made: A pound of anthracite coal is supposed to contain 90 per cent. carbon, a pound of bituminous coal contains 85 per cent. carbon and 5 per cent. hydrogen, a pound of oil contains 86 per cent. carbon and 14 per cent. hydrogen, and all heat-producing power of the carbon and hydrogen in the theoretical part of the table is calculated by means of the well-known heat units of these substances."

TABLE. — *Relative Heat-producing Power of Coal and Oil.*

	Pounds Oil.	Pounds Coal.
Theoretical anthracite, ...	1	1.61
Theoretical bituminous, ...	1	1.37
Urquhart's experiments, ...	1	1.756
Peninsular Car Company, ...	1	1.742
Elevated Railroad, New York, ...	1	1.785

It would seem by this table that a pound of oil is as good as one and three-fourths pounds of coal.

From a report of Mr. C. E. Potter to the Mining Engineers we get the following: "Fuel oil was first substituted for coal at the South Chicago Works of the North Chicago Rolling Mill Company in September, 1888, and was first applied to a battery of boilers in the converting department. This battery consists of fourteen tubular boilers 15 feet long by 5 feet in diameter. To operate these boilers with coal the following men were required for twenty-four hours: 14 stokers, 3 ash wheelers, 6 men unloading coal, 2 water tenders, making a total of 25 men. With fuel oil the following men are required to operate the same boilers: 2 water tenders, 4 men to attend to the burners, making a total of 6

men. This gives a saving of 19 men by the use of fuel oil in place of coal, which, at an average price of $2 per day each, would give a saving of $38 per day. Comparing the consumption of fuel oil with that of coal, we find that for the week ending Jan. 5, 1890, with an ingot out-put of 6,403 tons, 2,731 barrels of fuel oil were used as against a necessary consumption of coal for the same work of 848 tons, showing 3.22 barrels of oil to be equivalent to 1 ton of Indiana block coal. Figuring oil at 60 cents per barrel and coal at $2.15 per ton, we have the cost of oil $1.93 as equivalent to coal at $2.15, making a net saving of 22 cents per ton."

To offset this we have the report of Mr. E. C. Felton at the same meeting, who says: "The best twelve hours' work showed 16 pounds of water evaporated by 1 pound of oil; the average was about 12 pounds water per pound oil, the temperature feed water being 160°. The use of oil is not so economical as pea coal."

Now there is nothing said in either case as to the kind of burner used. The burner or the application or the oil might be to some extent responsible for the difference indicated.

With the Archer Gas Fuel Process at the P. C. Cheney Company's works, the average result as obtained in everyday practice shows an evaporation of 18.2 pounds of water at 212° to 1 pound of oil, while the maximum evaporation for any one hour was 19.2 pounds. The gas is applied to three Manning upright boilers, generating an average of 165 horse-powers each. The greatest amount of water evaporated for one hour per boiler was 6,000 pounds, while the average for four months has been 4,000 pounds per hour, with feed water varying as it returned from the mill from 34° to 140°. The same boilers running on coal gave an average evaporation of 8.55 pounds of water. With these results it would seem safe to claim an evaporation with oil equal to twice that of coal, or, in other words, that one pound of oil will do the work of two pounds of coal; at the same time I

should not be willing to guarantee this result in every case, for reasons already expressed.

Suppose for safety we take 1 pound of oil to equal $1\frac{3}{4}$ pounds of coal; then allowing for saving, due to cost of handling both inside and outside of the fire room, we will find that 1 pound of oil is equal in value to 2 pounds of coal, and with a gallon of oil weighing 7.3 pounds, and a barrel containing 42 gallons, the relative value of the two would be as follows: —

Price of coal per ton.	Price of oil per barrel.	Price of coal per ton.	Price of oil per barrel.
$2 50	$0 68½	$4 00	$1 10½
2 75	75½	4 25	1 17½
3 00	82½	4 50	1 24½
3 25	89½	4 75	1 31
3 50	96½	5 00	1 38
3 75	1 03½	-	-

Proving to his satisfaction that 1 pound of oil is equal to $1\frac{3}{4}$ pounds of coal, Dr. Dudley continues: "Assuming, therefore, that a barrel of oil contains 42 gallons, that a gallon of oil weighs 7.3 pounds, and that 2,000 pounds is a ton of coal, we have the two following formulæ, which will enable us to compute the price that we can afford to pay for oil per barrel if we know the price of coal per ton, or the price of coal per ton to be equivalent to oil at a given price per barrel: —

$$\frac{2{,}000 \times \text{price of oil per barrel}}{\text{Weight of oil per gallon} \times \text{number gallons in barrel} \times \text{ratio oil to coal}} = \text{Equivalent price of coal per ton.}$$

$$\frac{\text{Weight of oil per gallon} \times \text{number gallons per barrel} \times \text{ratio oil to coal} \times \text{price of coal per ton}}{2{,}000} = \text{Equivalent price of oil per barrel."}$$

By the use of these formulæ, the following table has been calculated: —

Oil per barrel at —	Fuel account alone considered coal per ton at —	All ascertained economies considered coal per ton at —	Oil per barrel at —	Fuel account alone considered coal per ton at —	All ascertained economies considered coal per ton at —
$0 20	$0 74	$0 65	$1 20	$4 47	$3 91
30	1 12	98	1 30	4 85	4 24
40	1 49	1 30	1 40	5 22	4 56
50	1 86	1 63	1 50	5 59	4 89
60	2 24	1 96	1 60	5 97	5 22
70	2 61	2 28	1 70	6 34	5 54
80	2 98	2 61	1 80	6 71	5 87
90	3 35	2 93	1 90	7 08	6 19
1 00	3 73	3 26	2 00	7 45	6 52
1 10	4 10	3 59	–	–	–

Although these figures agree very well with the performances of some apparatus, I am free to say that I believe them to be better than the results obtained by the majority. From the most reliable information which I can obtain the maximum evaporation per pound of oil as found in every-day practice is from 13 to 14½ pounds of water, while the average will not exceed 12. An engineer for some years employed by the Standard Oil Company, whose business it was to apply oil fires to boilers wherever there was an opportunity, makes the statement that throughout his long experience testing different burners he never obtained over 14½ pounds evaporation, while the average was as low as 12 pounds.

Recently we have heard of tests where 24 pounds have been reached, but the best result to my knowledge ever obtained was 92 pounds of water to 1 of oil.

Among the objections raised to the general use of oil as a fuel is that the demand may very soon over-reach the supply; that oil is liable to give out at any moment; or the question is asked, "Is not the supply limited?" and the question

comes so often I feel as if I should devote a few moments to its answer, although to give all the data would take volumes.

The extent of the oil region in America is familiar to but few of us, and but few realize how little of this region is at present developed. Aside from the Pennsylvania and Ohio fields, oil is found in quantities in Indiana, Kentucky, Tennessee, West Virginia, Colorado, New Mexico, Wyoming and California, and there is no doubt but that oil will be developed in Utah and Montana. Canada contains extensive fields, and also Old Mexico, Peru, Argentine Republic, Brazil, South Australia, New Zealand, India, China and Japan, while Russia has the largest fields in the world. But a small part of any of these fields is to-day furnishing oil, as the demand is so limited.

Without question the centre of the oil supply of the world is the Caspian regions of southern Russia. Although but little developed, comparatively speaking, still the production of American oil is but a drop compared with the production of the Caspian region. The central depot of this region is at Baku on the Caspian Sea. Baku has for two thousand five hundred years been famous for its marvellous springs of petroleum oil, and there is historical evidence that for very nearly one thousand years its resources have been drawn upon for surrounding nations, and there never has occurred in the region any phenomenon calculated to provoke or sustain the belief that the supply is intermittent, limited or likely to rapidly come to an end. Even the hills that stretch beyond the peninsula of Asheron near by have flared with petroleum gas fires for countless ages.

We have no direct testimony that the petroleum was exported as an article of commerce earlier then the tenth century, although there is no reason to disbelieve that it was used before then as light and fuel by the surrounding nations.

Mr. Jonas Hanway in his book entitled "An Historical Account of the Baku Trade over the Caspian Sea," says: "The earth around this place for above two miles has this

surprising property, that by taking up two or three inches of the surface, and applying a live coal, the part which is so uncovered immediately takes fire, almost before the coal touches the earth. The flame makes the soil hot, but does not consume it, nor affect it or what is near it with any degree of heat."

Speaking of naphthal springs, which abound in this neighborhood, he continues: "When the weather is thick and hazy, the springs boil up higher and the naphtha often takes fire on the surface of the earth and runs in a flame into the sea in great quantities, to a distance almost incredible. In clear weather the springs do not boil up above two or three feet. In boiling over, the oily substance makes so strong a consistency as by degrees almost to close the mouth of the spring. Sometimes it is quite closed, and forms a hillock that looks as black as pitch, but the spring which is resisted in one place breaks out in another. Some of the springs, which have not been long open, form a mouth of eight or ten feet in diameter."

Not only is petroleum found on the surface of the ground but it even comes to the surface of the sea.

Quoting from "Old Ali, or Travels Long Ago," by Hatchards, London, 1881: "In the evening I made an expedition with Colonel Fragauk to see the naphtha fires on the sea. Fragauk had his long boat manned by ten men. He and several of his friends and myself left the quay just as the sun went down. We were soon far in the open bay, and then, rounding a long promontory, entered another and in half an hour more we reached the spot. Gas was bubbling up in several places near the boat, the water looking as if it were boiling. The distance from land is about half a mile and the depth of the water fully three and a half fathoms. A strong odor of naphtha pervaded the air. One of the sailors then threw out a piece of lighted tow, and after one or two ineffectual attempts the waves were wrapped for several yards in flames. It was quite dark so we saw it beautifully. It was a most extraordinary sight, —

the sea as though it were on fire, a patch of bright flame burning upon its cold bosom. Setting the Thames on fire one has heard of, but I never thought I should really witness the sea in a blaze. We rowed around it and then away. The flame could be seen dancing up and down with the waves until we had gone nearly a mile distant. The wind then blew stronger and extinguished it, for it suddenly disappeared."

There are several spots on the Caspian where gas bubbles up in the same way.

Mr. Marvin in his book says: "It is particularly worthy of note that none of the travellers who have visited Baku since Peter the Great have expressed any doubt as to the durability of the petroleum supply. Often in the middle of the sea naphtha streams bubble up, clothing the ripples far and near with a thin, irridescent coating."

One more opinion I will cite, that of Professor Mendelaieff, who says: "The potentiality and productiveness of the Baku oil regions are incomparably superior to that of Pennsylvania. Comparing the results achieved in the two countries on the one side, and the average depth and total number of wells on the other, it may be justly said that the natural petroleum wells of Baku, as far as our knowledge goes, have no parallel in the world."

I have quoted these few opinions as being interesting and reliable. Now when we consider the fact that although Baku is the centre of the petroleum regions of the continent, the oil fields of Russia alone contain fourteen thousand square miles, according to the official estimate.

These figures, although seemingly large, are without doubt within bounds. In the Caspian oil regions alone the oil strata runs direct from the Crimea across the Caucasus and under the Caspian to the Balkan hills beyond, a distance of fifteen hundred miles, which would alone give more than the area referred to. As to the accessibility of this supply to our own markets, I can do no better than to quote the English correspondent, who says: "With regard to

the accessibility of the supply, the Baku deposits lie about the same distance from the Black Sea coast as the American oil fields do from the Atlantic littoral. If the Suran Pass of the Lesser Caucasus acts as an impediment, lacking in the case of America, it should be remembered that steps are already being taken to remove this obstacle; that, further, Baku possesses in the Caspian and Volga a splendid waterway close to the oil fields, surpassing the communications of Pennsylvania; and to this should be added, that for the past four years crude oil has been selling on the spot at Baku at the maximum rate of fourteen times cheaper than on the spot at Pennsylvania, while the minimum rate prevailing last autumn was one hundred and twelve times cheaper than that of the American oil."

All of the locomotives in southern Russia, all of the steamers on the Caspian and most of them on the Black Sea, use oil as a fuel, and there is no doubt in my mind but that some time in the near future we will see Russian oil landed in Boston by regular lines of tank steamers.

Another point which causes some discussion is the matter of fire risk. Contrary to the general opinion petroleum itself is not easily inflammable. I have extinguished a fire in a bunch of waste by dipping it into a pail of petroleum oil. The great danger is from the gas which arises from it, and great care should be used against the introduction of fire into a closed tank or near an open one filled with the vapor.

We had an example of the danger of this in an accident which happened this morning about three o'clock in Manchester. It seems there was a car which came in by the midnight freight, — an oil-tank car, which had been in collision somewhere and was leaking badly, and the railroad people telephoned to the mills and told them that if they could unload quickly they could save the oil. The two men who handled the oil regularly were called. They were asleep. They were called, and although they were perfectly familiar with the use of the oil and handle it every day, without thinking one of the men went and got his lantern,

went over to the side track, jumped on top of the car, pulled open the man-hole and looked in to see how much oil was left. The result was he lost all his hair and whiskers. There was quite an explosion, but the oil did not catch fire. The gas exploded and burned the face of the man who was looking in, and another man had his hand on the man-hole and it burned his hands, but the oil did not ignite. We succeeded in drawing the oil all off. There was only about a quarter of it gone.

The storage tanks, if possible, should be buried below the surface of the ground with all the connections to it also buried. Then the tanks should always be placed so that the level of the oil in the tanks will never be higher than the fire-box. In other words, all apparatus fed by gravity are more or less dangerous. The accumulation of any amount of oil in the fire room or fire-box should be avoided, not that I should fear any trouble arising from the oil itself, but in case of accident to the pipes or apparatus we are liable to have considerable quantities of oil running about on the floor, which would neither be pleasant nor safe. I have had several interesting conversations with insurance men on the subject, among them a well-known inspector for a mutual company, and in every case the opinion was, that if these precautions are carefully followed there is no risk attending the burning of petroleum oil for fires. With coal or wood the beginning of combustion is sparks and the end ashes and cinders, which must be disposed of.

Some objection has been raised to the use of oil on account of the unpleasant odor. There need be no trouble from this. If oil is kept in open tanks or spilled about there will, of course, be an unpleasant odor until it evaporates, but if it is handled carefully in pipes and closed tanks, without leakage, the slight odor which may be apparent will be much less objectionable than the heavy soot or smoke which arises from our numerous chimneys, and which upon the slightest provocation drops down upon us.

To close, then, I would say that I do not consider that the

great saving to a plant with a most efficient boiler service on coal is to be in the first cost of the fuel, but in the advantage derived from ease of handling, labor in the boiler house, cleanliness, absence of waste and other items which do not appear on the books.

We must bear in mind that but a very few of the steam plants are doing all that it is possible to do with coal, the average evaporation being as low as seven pounds of water to one pound of coal. Again, the efficiency of a coal fire varies greatly from one moment to another, for as soon as it is up to its maximum heat fresh coal must be applied, and by so doing the temperature is again reduced. On the other hand, with oil, the temperature is always at its maximum and constant.

The principal advantages, therefore, which fuel oil has over coal for boiler work are the desirable saving in the first cost; economy in labor by dispensing with the handling of coal and ashes, and the frequent cleaning of fires and flues; the perfect control at all times without opening the fire-box; ease and quickness of lighting and extinguishing, thereby doing away with the drawing and banking of fires; the increased efficiency of the boilers; great saving of room, as the oil occupies only one-half as much space as coal and can be stored below ground; the ease, rapidity and cheapness of handling outside of the boiler house, as oil can be pumped as easily as water, and carried in pipes to any distance without loss. To be added to this, the fact that the life of the boiler must be increased by the use of oil, partly on account of the absence of sulphur and ammonia and partly by the steady temperature in the fire-box, thereby doing away with the constant expansion and contraction of the metal, also the great saving in first cost of plant, no lofty and expensive stack being required.

If it is so that all these advantages are derived from the use of oil under boilers, I must confess that I fail to discover any particular advantage left to those using coal.

The situation then, as it appears to me, is this: The us

of fuel oil under steam-boilers has ceased to be an experiment. It is demonstrated beyond doubt that it is a practical success. With reliable apparatus and good application there is both safety and economy. The oil supply of the world is equal to if not greater than the supply of coal. If the local supply should fail, to change from oil to coal is but the work of a few minutes.

The vital question, then, is one of economy. The price of crude oil is the important factor, and with this satisfactory, the introduction of oil into every mill in New England will be only a question of time.

At the conclusion of his paper Mr. FISH added: —

There is one thing here that I would like to refer back to. Reference is made to the evaporation of ninety-two pounds of water to one pound of oil. Now that has been recently done, so they say, and I don't know how they did it. I did not see the plant myself, but a good many of you were interested in it and there were a good many figures given out. In fact, there was so much interest in it that every other part but the figures was completely in the dark, and I think it would be well, with your permission, to let somebody who has investigated this let us know what he found out, and I would like to call on Mr. Manning, if you have no objection. Mr. Manning, I would like to know about that East Cambridge matter.

Mr. MANNING. Mr. Chairman and Gentlemen: There are one or two points that I wish to discuss a little on this paper of Mr. Fish. In the first place, the question of the value of oil fuel is largely one dependent on the reliability of the apparatus to use it with. There have been a great many different schemes for using it introduced that have given more or less trouble, as he has said. The scheme that he has been using there I have watched pretty closely; I watched it ten years ago, when Archer first got it out. The scheme was all right for getting his heat at that time, but his apparatus was not reliable. I think his present apparatus

is about as reliable a piece of mechanism as I have seen. Therefore, that being settled, it comes down to a question of the cost of the fuel. In mineral oil there are from 21,700 to 21,900 heat units per pound of oil, and if we can economize all of that heat, utilize the whole of it, we can afford to pay pretty well per pound for oil.

Now, under the conditions that Mr. Fish spoke of, where he was making steam at eighty pounds from feed water, varying anywhere from 40° to 134° temperature, the average cost, taking the average feed water at 87°, the total heat units required to make a pound of steam from a pound of water at 87°, the steam pressure at eighty pounds per inch, would be 11,126 units per pound. That being divided into the highest value for oil would give us nineteen and four-tenths pounds, provided that none of the heat escaped, and every particle of it went into the water. Mr. Fish has claimed nineteen and two-tenths pounds, very close to perfection.

Mr. Fish. That is for one hour?

Mr. Manning. Of course; if you can do it for one hour you can do it for a year.

Mr. Fish. No, sir; I beg to differ with you.

Mr. Manning. There are one or two items, though, that have been omitted from that calculation. The first is that he has used a portion of the steam made for the production of his gas. This he has made no exact measurement of, but in my opinion it would be at least five per cent. Whether it is more or less than five per cent. I do not believe he has any very definite idea; and I am certain I have not; but I think that with that process five per cent. — it may be less, it may be as low as two per cent. — of the whole feed water is used in making the superheated steam for the gas, — that is, used merely as a vehicle for the oil, carrying it into the fire. The dissociation of it, in the first place, I do not believe in; in the second place, they gain nothing by it. They would lose as much as they would gain by burning the hydrogen, so that if that goes on it is of no importance. The use of the

steam is as a vehicle for oil, and undoubtedly it is the very best vehicle. It is better than air for very many reasons, and its success in this case shows it.

There is another little item that he has left out, and that is the coal burned under this superheating arrangement. It is a small item, but still in an accurate statement of an actual experiment of just what may be got from it, it should be taken into consideration, and those two items should be deducted from the final results.

He says on page 63: "The same boilers running on coal gave an average evaporation of 8.55 pounds of water." I take it, under the same conditions, that it is from the same feed water to the same pressure of steam. That is the poorest showing ever made, according to my knowledge, with these boilers. Of course I am personally interested in the matter. The boilers are of my design and I think their average showing is better than that. I do not think he has taken into consideration whether he is using dry coal or wet coal. There is no statement about that, but I know his coal-shed is out-doors, and I think it is very likely that some water in that coal may have accounted partly for that. I do not want you to go away with the idea that that boiler would only average 8.55 pounds of water per pound of coal.

Now, oil fuel has been a very much greater success in iron manufacturing and in places where very high temperature has been necessary, as is spoken of in Mr. Fish's paper, where they are competing with coal at two dollars and fifty cents a ton. It would be the natural query, without any further explanation, why couldn't you compete with steam power on the same figures? It is for the reason that temperature below 2,500° or 3,000° is, for these iron-heating purposes, of no avail. With the oil, that temperature can be kept right along; with the coal fire it is impossible. It is often from 1,500° to 1,800°. All the heat made during that time, until it gets up to the temperature at which it can be utilized in the iron processes, is wasted, which waste you do not incur with the oil. A good boiler would utilize the heat down to

400°, and therefore there is not the same necessity for extreme heat as there is in brick kilns, porcelain kilns and such things, where oil will compete with coal at two dollars and a half a ton. It would not do it for steam purposes, because you get a higher efficiency from the coal as well as from the oil.

Mr. Fish has referred to some miraculous results that have been obtained in the neighborhood of Boston, from another oil plant, where they were evaporating from seventy-five to ninety pounds of water to the pound of oil. I happen to know a little of that because I was requested to investigate the thing; make a preliminary investigation; see how much there was in it. One gentleman, within a week or two, reported an actual experiment that he carried out himself, lasting sixteen hours, where he evaporated seventy-five pounds of water to a pound of oil. Well, I am not much of a believer in miracles at the present day, and that is too much of a miracle. I told the people, after reading these reports, that there were two horns of the dilemma, — one was that the thing was a fraud and the other was that it was the greatest discovery of modern ages, and if it was the latter we wanted to get into it as soon as we could; but looking over the plant, the arrangement was very well put up, and was of such a nature that I reported the only way to investigate it was for somebody to go there and spend from ten days to two weeks right on the spot. It wasn't a thing that could be investigated in a few hours, and I hadn't the time to devote to it, but I could find a competent person, if they wanted him found. There was a gentleman selected and sent over, and he made his preliminary investigation and laid down certain lines for the investigation which the promoters of the scheme said reflected on their integrity, and therefore they could not allow the experiment to go on. That, to my mind, finishes the thing as a fraud, and there is no question in my mind that any claim to get more out of the oil than there is in it is a fraud. There is nothing in the oil beyond what heat constituents will give, — the hydrogen and carbon will

give certain results, — or our physicists have been mistaken for the last hundred years, and unless they have been mistaken the whole thing is a fraud.

Mr. Fish. I would like to say just one word. In the first place Mr. Manning says my system. Well, now, it isn't my system at all. It is a system that, it happens, was put into the mill where I am. When this paper was written I had no more to do with it than any of you gentlemen, but that probably was a slip of the tongue. Now, in regard to the matter of steam used, I did neglect to say that the amount of steam used in this process was much the same as in other processes, — I cannot say exactly as to quantity, but all steam users take steam as he says, to carry the oil, or as a conveyer. They all use steam; and they take it from the boiler. The Aerated Company used steam, and I do not know of any process where they do not use power or steam, — that is, power in one shape or another, so that this using steam is not an item which appears in that process, and does not in any other process. As to the coal used, I referred in the paper to the fact that it did have to be used, but I neglected to say how much it took. It takes on an average about four hundred pounds of coarse screenings, which we get from the coal sheds, and which costs us about two dollars a ton. That is, twenty-four hours, running day and night. The cost of that, to run the producer, is about forty cents a day, to be added to the other items which I put in the paper. Referring to Mr. Manning's tests of 8.55 pounds, I do not want Mr. Manning to think that that is all his boiler can do; but tests taken at the same time as the tests on oil, gave us 8.55 pounds.

A Member. How was the coal as to being dry?

Mr. Fish. I did not evaporate the coal. I do not know but the coal was in about the same condition as almost everybody's coal, unless they have got a good house to store it in. The coal had been out of doors and was out of doors, but whether the time that the test was made was at the end of a six weeks dry time or after a thunder-storm, I could not say. I should suppose it was the average test of coal.

Mr. MESSENGER. I would like to inquire in regard to the difference in efficiency of the oil. It says on page 56: "With an experience covering eight months of constant testing on a battery of three one hundred and seventy horse-power boilers, I find that there is at least a difference of twenty per cent. in the efficiency of the oil, all supposed to be the same grade of crude." I ask you this question, as our engineer and myself had some difference of opinion in regard to it. I handed this paper to him, and he has enclosed that in parentheses. I have some doubt as to there being the difference in the oil that he has fixed. I want to ask you how you arrived at that conclusion, that there was so much difference in the oil?

Mr. FISH. We made thorough tests. The readings were taken every hour. Along the first part of it it was done with the tanks entirely; then I put on a water and oil meter and took the two, and the last part of the time we have used a meter. These records were handed to me after they were taken by men who were competent; and a great many I have taken myself, and Mr. Manning has taken a good many; and I notice there was a very great increase in the consumption of oil, on certain days; and in going through these figures the increase in consumption is directly traceable to certain tank cars. They would come in and say, "We are not doing as well to-day as we were yesterday." I would ask, "What is the matter?" They would say, "We have opened a new car this morning." I cannot say that it is absolutely so, but to the best of my knowledge and belief I will say there is twenty per cent. difference in the oil. You may get fifty cars all right and then one car different
the trouble is with the oil is also made very a
testing it.

A MEMBER. I would like to ask if a rec
the outside temperature?

Mr. FISH. Yes; the tests were taken a
navy department. Mr. Manning knows h
taken.

A MEMBER. The reason I ask that is on account of the fact that I noticed that when our engineer tried poor oil the temperature was low out of doors, and when it was good it was a warm day.

Mr. FISH. I could not see that the temperature had any effect otherwise than that the oil seemed to be a little thicker, but it pumped as easily and burned as easily. It goes into our apparatus at about a uniform temperature. We warm it in a coil.

A MEMBER. As I undertand it, these tests were made for heating the mill?

Mr. FISH. Power and heating purposes.

A MEMBER. Referring to page 65, in reference to the test where ninety-two pounds were said to have been obtained, we understand Mr. Manning's remarks and his conclusions that this was a clause with reference to this one item here. I would like to ask you, Mr. Fish, if you understand from what Mr. Manning said, that, aside from the few exceptions that he took to your paper, he excepted to the general conclusions with reference to the relative merits of oil and coal? It is interesting to the members generally to know whether Mr. Manning generally endorses the conclusions reached by Mr. Fish's paper.

Mr. MANNING. Well, as far as they have come under my observation I think the observation has been very carefully kept, and I think the results are very near the truth. Of course in carrying out exact tests on this matter the steam taken for making this gas should be taken from another boiler, so as to get a measure of that, and then deducted, and the results of the boiler is simply the net steam carried off for useful purposes, not the water fed to the boiler. Such a test will be made sooner or later. Indeed there are undoubtedly very many places where oil fuel would be profitable to put in to-day where it is largely a matter of freights; and then again, if we develope two good fuels that we can use interchangeably, and the change from one to the other is a matter of very small consequence, we have more or less control of the production

of oil and coal; that is, they come more in competition, and it has an effect on the price.

The PRESIDENT. Gentlemen, we have two other papers before us, and I want to say that there is another paper on oil fuel here, if you want to hear it. The Board of Directors called upon two other gentlemen to prepare papers. Unless the paper is called for, we will omit it.

A MEMBER. Mr. President, I want to say one word. I do not know to what extent establishments have introduced the use of oil for the production of power, but I know of one or two that have introduced it and have abandoned it since. I want to ask Mr. Fish if he knows the reason.

Mr. FISH. Well, I know this: that the use of oil has been worked up in the same way as the use of electricity or the telephone; and I know of mills where they used oil and threw it out because coal was cheaper; and also know of other mills where they could not get a satisfactory fire; and also mills where they could not get an apparatus which was satisfactory, — the pipes would fill up; so there are numerous reasons why oil should be thrown out. It is pretty hard work for you to put your finger on any one reason, because there are so many.

Mr. ATKINSON. It became necessary for the underwriters to look into this many years ago. The conclusions which were then reached on any information which could then be had were these: that where mills could get their coal for less than four dollars and a half for the production of steam they had better stay there at present; the conditions being not then well established. The first plants were put in under very dangerous conditions, the oil running to the fire-boxes instead of running back from the fire-boxes. Since then the oil fuel has been adopted for metallurgical purposes very widely. Even in York, Penn., close to the coal fields, liquid fuel is used in metallurgy, without regard to the price. Those who are using liquid fuel in this way are experimenting upon it with the utmost skill and care, and it is not necessary for

any textile manufacturer to run the risks of the experiments when they are still in a crude condition. The investigation is going on under the processes necessary to adapt fuel oil to metallurgy, to the end that by-and-by it is probable you will get the results yourselves, without any doubtful or dangerous experiments.

Mr. Fish. I would like to ask Mr. Atkinson what he considers the dangerous features to-day, as it is applied.

Mr. Atkinson. I think the chance is that liquid fuel may be as safe as coal if proper attention is given to the plant. We have had our fears of danger allayed since the matter first came up, and the right directions were given for putting in the plant. We draw our lines where the plant was not put in in a proper way; but since it is now a necessity to use liquid fuel in some branches of metal working, not merely a questionable matter of expediency in making steam, it is better to keep on the safest side until absolute assurance of safety may be given.

The President. Many of the older members, at least, remember that Mr. Oliver P. Hussey was a very active member of the Association, and contributed largely to the literature that we have in our published volumes; and I have great pleasure in introducing Mr. O. S. Hussey, a nephew of that gentleman, who will read a paper on "Electricity in Mill Work."

A Member. Before beginning I would like to make one remark. If it is a long paper I would suggest, as time is so valuable, that he read only the principal items, passing over the minor ones; and then give opportunity for remarks and for questions. It will give more time for discussion.

The President. If that is the pleasure of the members I have no doubt Mr. Hussey will follow the suggestion.

ELECTRICITY IN MILL WORK.

By O. S. Hussey, Boston, Mass.

During the past few years, the applications of electricity to power transmission have increased to such an extent that one can hardly realize it is a little more than ten years ago that electricity became of practical use to the commercial world. This increase is due to the great economy obtained in electrical transmission, and to the flexibility of the apparatus employed, when installed under suitable conditions.

Electricity is used to-day for transmitting thousands of horse-power in units as small as one-eighth horse-power and as large as three hundred horse-power, one as successfully as the other, over distances ranging from five hundred feet or less to five miles and more.

Inasmuch as the terms used in electrical parlance are doubtless more or less unfamiliar ones to you, it might be well perhaps to give you definitions of some of the most common ones.

It is quite admissible to say that there are some quantities in electro-technics which have similar functions to distance, weight and capacity in mechanics, and that the analogies to these may be used to illustrate the nature of the different electrical phenomena.

This can best be shown by a mechanical illustration.

We all know and understand the construction of an ordinary steam-pump; when in action it sucks water from a lower level and raises it to a higher level. If the upper level is connected by a pipe or other means to a lower level, a

current will be set in motion from the lower level through the pump to the upper level and thence through the pipe back to the lower level.

The pressure of the water which is derived from the pump, being of a positive nature at the delivery end and negative at the suction, corresponds precisely to the electrical pressure or potential in batteries and machines.

In both cases, if they are allowed to equalize themselves, current will be produced in a certain direction, from the positive to the negative in the external circuit, and from the negative to the positive through the machine or battery itself. This pressure corresponds to pounds per square inch in mechanics, and is called, in electrical work, electrical pressure, electro-motive force or potential, and is measured in volts.

This pressure is measured from some zero point; in the case of water the zero point is the ocean, while the zero point in electricity is the earth, and is the natural pressure of electricity in the earth itself.

In electrical phenomena an electro-motive force is necessary to create a current of electricity. This current, expressed in amperes, represents the quantity per second.

There is also an electrical resistance (measured in ohms) which opposes the passage of an electrical current through a conductor, just as in mechanics a frictional resistance opposes the passage of water through a pipe.

The electrical resistance increases with the length of the conductor and diminishes as the area of cross section increases. It also depends upon the nature of the material used as the conductors. This material used for conductors is almost invariably copper wire. It has seldom been found advisable to use a wire larger than No. 0000, Brown & Sharpe gauge, because of the difficulty in handling. The amount of power this size of wire will transmit depends upon three facts, — the distance to be transmitted, the voltage used, and the loss of power to be allowed in the transmission.

For example: allowing a loss of power of ten per cent. in the transmission, a single No. 0000 wire will carry sixty horse-power a distance of 5,471 feet at 500 volts. Allowing a loss of twenty per cent. in the transmission, the same size wire will carry sixty horse-power about 12,300 feet, using the same voltage. That is to say, the same amount of power can be forced through the wire a greater distance if a greater proportional loss in the line is allowed. In the first case, the actual loss on the wire would be about seven horse-power; in the second, about fifteen horse-power. The power lost in the line reappears as heat, the rise in temperature having a definite relation to the amount of power lost.

The above, then, briefly defines the three most common terms used in electrical work of all descriptions.

The question of long-distance transmission of power by electricity is one which has only been recently considered by engineers. If a mill is located upon a water-power which is only sufficient to furnish enough power for a portion of the year, it has always been considered necessary to put in an engine of sufficient capacity to "help out." The fact that the power of a fall, located at some distance from the mill, could be utilized at the mill in connection with the power already there, through the medium of electricity, has not even been thought of.

The writer has in mind a mill which is located under similar conditions. A one thousand horse-power engine is installed at the mill, and whenever necessary is run in connection with the wheels. There is a water-power about two miles from the mill of over 2,000 horse-power capacity. How easy it would be to transmit this power to the mill, by proper electrical apparatus, and use it instead of the engine!

The Thomson-Houston Motor Company is at present building a generator and motor for use near Hartford, Conn., and the amount of power to be transmitted is three hundred horse-power. The source of power is ten miles away from where power is to be used. It is proposed to use in this case three thousand volts, owing to the great distance carried.

Again, a large paper company, located near Portland, Me., is driving its entire mill by electric power, which is transmitted a considerable distance. The voltage used in this instance is only five hundred, as the power is subdivided into small units and distributed throughout the mill.

The province of this paper, however, is not so much the consideration of the subject of long-distance transmission as it is to show, if possible, how electric power can be used advantageously in performing some of the work, in and about a mill, now done by other means.

This work may be divided under the following heads: —

1st. Electricity as applied to isolated motors, located in different parts of a mill, and used to drive lines of shafting, separate machines, etc.

2d. Electricity as applied to driving tram cars suitable for handling all classes of goods, both in the mill and about the mill yard.

3d. Electricity as applied to hoisting machinery of all descriptions, including elevators, whip and drum hoists, etc.

4th. Electricity as applied to pumping machinery.

Assuming that there is sufficient power at the mill, either steam or water-power, let us then consider what is necessary in the way of generators for supplying power to the different electrical apparatus, wherever located.

Fig. 1 shows a generator of eighty-five horse-power capacity, suitable for power transmission, manufactured by the Thomson-Houston Electric Company.

It is equipped with a sliding base and self-oiling bearings. The weight of this machine complete is ten thousand pounds.

This same company builds generators of this design in capacities ranging from five horse-power to one hundred horse-power. It also builds machines, but of another type, of one hundred and fifty horse-power, two hundred and fifty horse-power, and three hundred horse-power.

For transmitting over distances such as would occur about a mill, both generators and motors should be wound for five

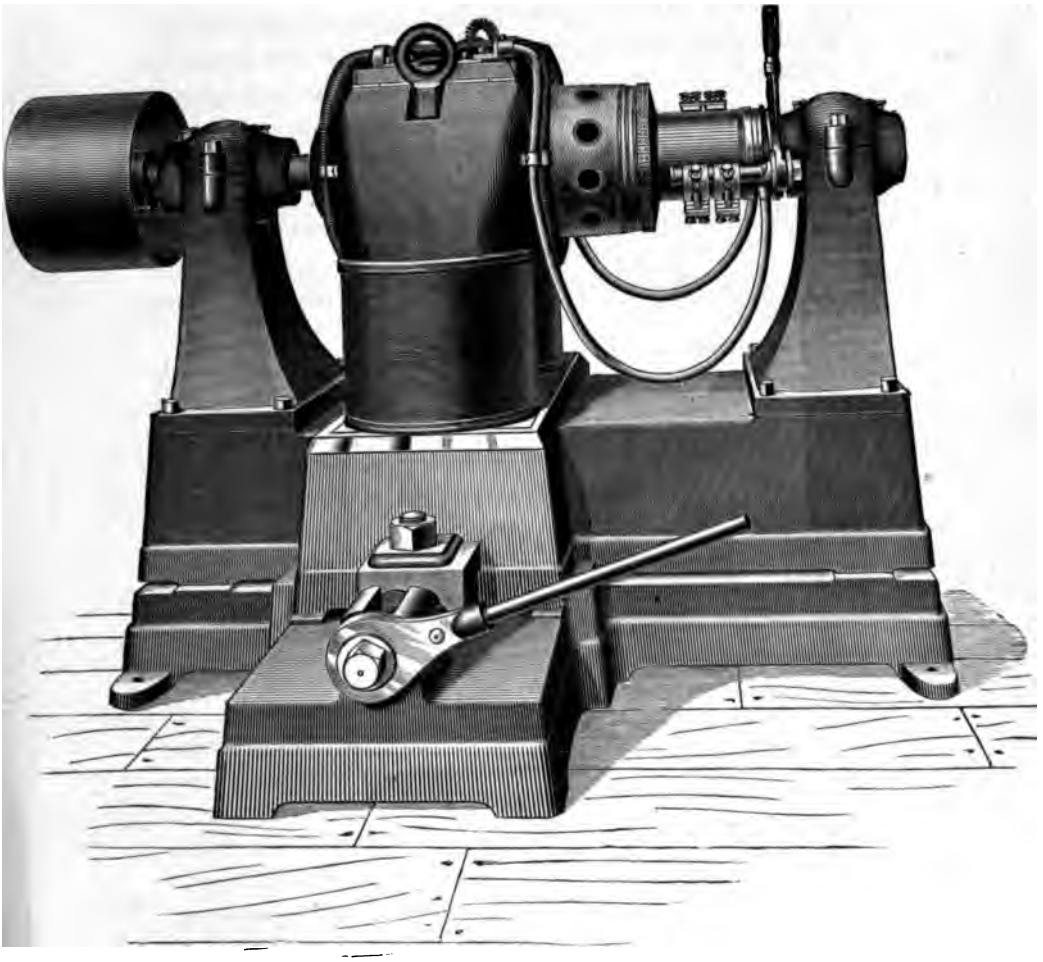

Fig. 1. — GENERATOR.

hundred volts, as this would insure the greatest economy in copper wire, without danger to persons handling the apparatus.

These machines, set upon substantial brick or stone foundations and fed with the best dynamo oil, should need practically no attention except at starting and stopping, as the modern generator is so wound that the voltage or electrical pressure is kept constant under any variation of load.

It is always better, where there are two or more machines in a generating station, to drive each of them from the existing water or steam powers through the medium of a friction clutch; by this means any one of them can be stopped, if necessary, without any other part of the machinery being shut down.

Let us now take up the different heads before enumerated, always bearing in mind the fact that the same generators can be used for all classes of machinery mentioned hereafter.

Electricity as applied to isolated motors, located in different parts of a mill, and used to drive lines of shafting, separate machines, etc.

The amount of power which would be saved by doing away with cumbersome jack shafts, heavy pulleys and dangerous belting has never been considered by many. As a rough approximation, one hundred feet of shafting, three inches in diameter, and making one hundred and twenty revolutions per minute, requires one horse-power to overcome its friction, under conditions of fairly good alignment and good care. Should this shafting become out of alignment, as is frequently the case, its frictional resistance would be proportionally increased.

It has been estimated that from thirty to fifty per cent. of the power generated in mills and factories is unremunerative, because of the wasteful method of driving in vogue at the present time. Should a judicious arrangement of electrical transmission be employed, on the contrary, fully eighty-five per cent. of the power developed by the wheels would be expended in useful work.

That the transmission and distribution of power by electricity is a profitable investment is proven by the large number of electric stations scattered throughout the country, and furnishing power to a large number of consumers, in small and large units. Not only can power be saved by electrical transmission, but also a large amount of space is made available for other purposes. An electric motor is of such dimensions that it can be suspended entirely out of reach, if necessary, on shelves or by other means, and driven in this position.

The following table shows the weight, floor space and outside dimensions of the standard motors manufactured by the Thomson-Houston Electric Company, of seventy-five horse-power and under: —

Horse-power.	Weight in Pounds.	Floor Space of Motor in Inches.	Floor Space (including Sliding Base) in Inches.	Outside Dimensions (including Sliding Base) in Inches.		
				Length.	Width.	Height.
1	145	$16\frac{1}{8} \times 10\frac{1}{2}$	$23\frac{1}{2} \times 16\frac{1}{2}$	19	$23\frac{1}{2}$	$17\frac{13}{16}$
$1\frac{1}{2}$	300	$20\frac{7}{8} \times 13\frac{1}{2}$	$28\frac{1}{2} \times 21\frac{1}{8}$	24	$28\frac{1}{2}$	$24\frac{3}{16}$
3	480	$25 \times 16\frac{1}{8}$	$24\frac{1}{2} \times 25$	$29\frac{1}{4}$	$24\frac{1}{2}$	$25\frac{3}{16}$
5	700	$26 \times 18\frac{3}{4}$	$30 \times 26\frac{3}{8}$	$31\frac{1}{4}$	30	$28\frac{7}{16}$
$7\frac{1}{2}$	1,080	$31\frac{5}{8} \times 21\frac{3}{4}$	$33\frac{1}{4} \times 31\frac{7}{8}$	$37\frac{1}{4}$	$33\frac{1}{4}$	$31\frac{3}{16}$
10	1,364	$34\frac{1}{4} \times 23\frac{3}{8}$	37×35	40	37	$32\frac{5}{8}$
15	1,950	$37 \times 27\frac{3}{8}$	$40\frac{1}{2} \times 37\frac{1}{2}$	44	$40\frac{1}{2}$	$36\frac{1}{4}$
20	3,160	$47\frac{1}{2} \times 30\frac{1}{4}$	$50\frac{3}{8} \times 49\frac{7}{8}$	58	$49\frac{7}{8}$	$41\frac{1}{4}$
25	–	–	$52\frac{3}{4} \times 62$	$62\frac{5}{8}$	62	43
35	*5,100	$55\frac{3}{4} \times 36\frac{3}{4}$	$57\frac{1}{2} \times 66\frac{1}{4}$	$67\frac{5}{16}$	$66\frac{1}{4}$	46
45	6,350	$66\frac{1}{4} \times 39\frac{3}{4}$	$65\frac{1}{2} \times 75\frac{1}{2}$	$76\frac{1}{4}$	$75\frac{1}{2}$	$50\frac{1}{2}$
60	7,050	$63\frac{3}{4} \times 40\frac{3}{4}$	$69\frac{1}{2} \times 78\frac{1}{4}$	$81\frac{3}{4}$	$78\frac{1}{4}$	$54\frac{1}{2}$
75	10,000	$73\frac{1}{4} \times 46\frac{1}{2}$	$76\frac{1}{4} \times 88$	$89\frac{5}{8}$	88	$63\frac{1}{2}$

NOTE. — The motors of the higher classes, from twenty horse-power, inclusive, are furnished with cast-iron sliding bases.

Another point which should be considered by mill men, and which would seem to be a very essential one, is this: —

* Approximate.

By a subdivision of shafting into small units, a much more complete control is had over it in case of accident or of any breakdown which is liable to occur, and which means, as mills are driven to-day, the shutting down of an entire room and sometimes of an entire factory, at an immense loss, while repairs are being made.

On the contrary, should motors in small units be used, simply that portion of the room in which the breakdown occurred would be stopped, the rest of the mill running as before.

It is unnecessary to go to the motor in order to stop it, it being a very simple matter to arrange a supplementary electrical system of running throughout the factory which will enable any employee, who should see the necessity of so doing, stopping the machine from different parts of the room.

As an electric motor has but one running part, the armature, there is very little about the machine to get out of order; but should an accident happen to any part of it, this can, under ordinary circumstances, be quickly repaired. If, however, the injury be of such a nature as to render it necessary to send to the manufacturer, a duplicate part could be returned in a comparatively short time.

The question of the spreading of fire in mills is one of great interest to mill owners, and anything that could be devised to aid in preventing this should be carefully considered. One method which naturally suggests itself is to isolate each room in a factory, as far as practicable, by closing all belt holes in floors and walls, thereby getting rid of that very dangerous element, the risk of carrying fire from floor to floor and room to room. No better method can be secured to accomplish this than the use of electricity for transmission. In cases where belt towers are used the arrangement is generally a very costly one.

The danger of fire occurring from the use of electricity has been reduced to a minimum by the many safeguards and protectors which are to be found in all well-installed plants.

The New England Insurance Exchange state, over their signature: "Permission to use electric motors has been fully granted in all risks controlled by this Exchange when properly installed. Under those conditions they add nothing to the danger from fire, and in our opinion are greatly to be preferred to steam-engines with their attendant danger. From an insurance stand-point, we heartily welcome the electric motor."

A notable instance of the use of electric power in the factory was in 1885, when the driving of all the shafting and machinery in factory "A" of the Thomson-Houston Electric Company was accomplished by using a motor of sixty horse-power capacity. The power required was from fifty to fifty-five horse-power. The company now employs in its factory over twenty stationary motors in the various departments, for the distribution of power.

By a properly proportioned winding of the armature and fields, automatic regulation of speed of less then two per cent. variation is obtained on all of the Thomson-Houston motors, no matter what the variations of load may be. This feature is of special value, as it permits the simplest possible construction of the motor and at the same time secures an automatic regulation of speed well within the range of that which is guaranteed for the best regulated high-speed steam-engines.

The next head to be considered is the application of electricity for driving tram cars.

The electric mill tramway, in its sphere, has operated fully as successfully as the electric street railway, although its adoption has not been so general. As yet many of the mills are not entirely willing to give up their old methods of transporting goods in and about their mill yards by means of hand or horse power, and to install an electric tram-road, the first cost of which will amount to considerable, but, after once put in, meaning a saving in operating expenses.

A mill tramway is practically a modified electric street railroad, the principle of propulsion being the same. Usually a single overhead trolley system is used, as in street railway work, the electricity being carried from the dynamo to the

motors under the cars by means of this trolley; the rails of the track, upon which the car runs, being used to carry the current back to the generator. Where the motor car is to be run inside of buildings, however, two trolley wires are used, one for the same purpose as before, *i. e.*, to carry the current to the motor, while the second is used for carrying it back instead of the rails. This is done in order to have a thoroughly insulated system throughout, and to do away with any sparking which might occur between the rails of the track and the revolving car wheels.

The amount of power generally used by motor cars in ordinary tramway work is either three horse-power or six horse-power; the former easily handling a load of five thousand pounds, and the latter a load of ten thousand, exclusive of the weight of the car, at a speed of four miles per hour on a level and straight track.

These motors are mounted upon platform trucks of any convenient dimensions. As they are hung from the axles of the trucks, the platform itself is available for carrying the load. These cars can also be used for towing other small cars, if desired, thus increasing the carrying capacity of the system very materially.

For hauling heavy loads, such as loaded freight cars, electric locomotives of thirty horse-power and over have been designed. These larger machines are also so constructed that the platform of the machine itself is available for loading, if so desired.

The small motor cars are built to operate on any gauge of track from 30″ to the standard 4′ 8½″. The controlling device is extremely simple and is so placed upon the car that one man operates it with entire control of direction and of speed. Ordinary curves and grades offer no serious objection to the operation of the system, as electric cars are now doing successful work on tracks having curves of less than fifteen feet radius and grades of over twelve per cent.

As before stated, the same generator used for furnishing power to stationary motors throughout the mill is equally

available for supplying the necessary current for propelling the tram cars. However, should there be no other work performed about the mill electrically, a generator of sufficient size to operate the tram-road can be placed in the engine room or wheel-house, and run directly from the existing power; the engineer or wheelman being perfectly able to give it what little attention it may require, without in any way interfering with his regular duties.

For transporting large and heavy loads about a mill, there are but two other systems besides the electric suitable for the work, *i. e.*, steam and cable tramways. The former is not desirable for two reasons: *First*, the large annual cost for operating a locomotive, as compared with almost any other motive power. *Second*, a locomotive would be dangerous about a cotton or woollen mill, where there is inflammable material liable to take fire by sparks from it; particularly, as is frequently the case, where power is required for both out-door and interior use.

The cable system has disadvantages also. Inasmuch as direction of motion of the cable is always the same, the cars would necessarily always move in the same direction in passing a given point, unless a second track be used having the return cable running in the opposite direction. This, in most mills, would be utterly impracticable and almost impossible. Again, the cable system is costly in power consumed, because the dead weight of the cable together with its frictional resistances has to be overcome at all times, whether cars are in actual use or not. With an electric system, however, the cost of operating is practically nothing when the car is not in use; when it is, the power consumed is directly proportional to the load carried.

The cost of maintaining a cable system is much greater than that required by an electric, because of greater wear and tear. In fact, the same arguments used in favor of electric street cars over cable cars can be applied to these systems in tramway work; and the best proof of the superiority of the one over the other is shown by there being in August, 1890, two hundred and fifty-eight electric railways in the United

States alone, with one thousand nine hundred and twenty-seven miles of track and three thousand and twenty-four cars in daily service or under construction, while cable roads are still comparatively a novelty.

The electric car also far exceeds the steam locomotive in its ability to climb grades. The latter is unable to overcome a rise of over two or three per cent. under favorable conditions, while, as has been stated, electric cars are working successfully on grades of over twelve per cent. This is an additional point greatly to the advantage of the electric system.

The Thomson-Houston Motor Company, which is doing the only business in the direction of mill tramways, has in operation or under construction at this time no less than fourteen roads equipped with tram cars or locomotives of from three to sixty horse-power each and capable of hauling loads of from five thousand to one hundred and twenty thousand pounds, at a speed of from four to six miles per hour.

The first mill tramway to be equipped by this company is located at the Tremont and Suffolk Mills, Lowell, Mass. The entire length of the track is about eight hundred feet, with a three per cent. grade. The car runs from one building, over a bridge, and the entire length of another building. The illustration (Fig. 2) shows the motor car in the interior of the mill. The car is used for transporting baled goods from the cloth room to the storehouse.

The next tramway equipped by the motor company is located at the mills of the Salmon Falls Manufacturing Company, Salmon Falls, N. H. In this case the car runs upon a track of standard gauge (4′ 8½″) laid with T rails. The platform of the motor car is fourteen feet long by six feet wide, and the truck is equipped with two motors of three horse-power each. This tram car is used for carrying cotton, and it is capable of handling a load of over three tons upon a five per cent. grade. The accompanying illustration (Fig. 3) shows the car standing upon a grade and being loaded with cotton.

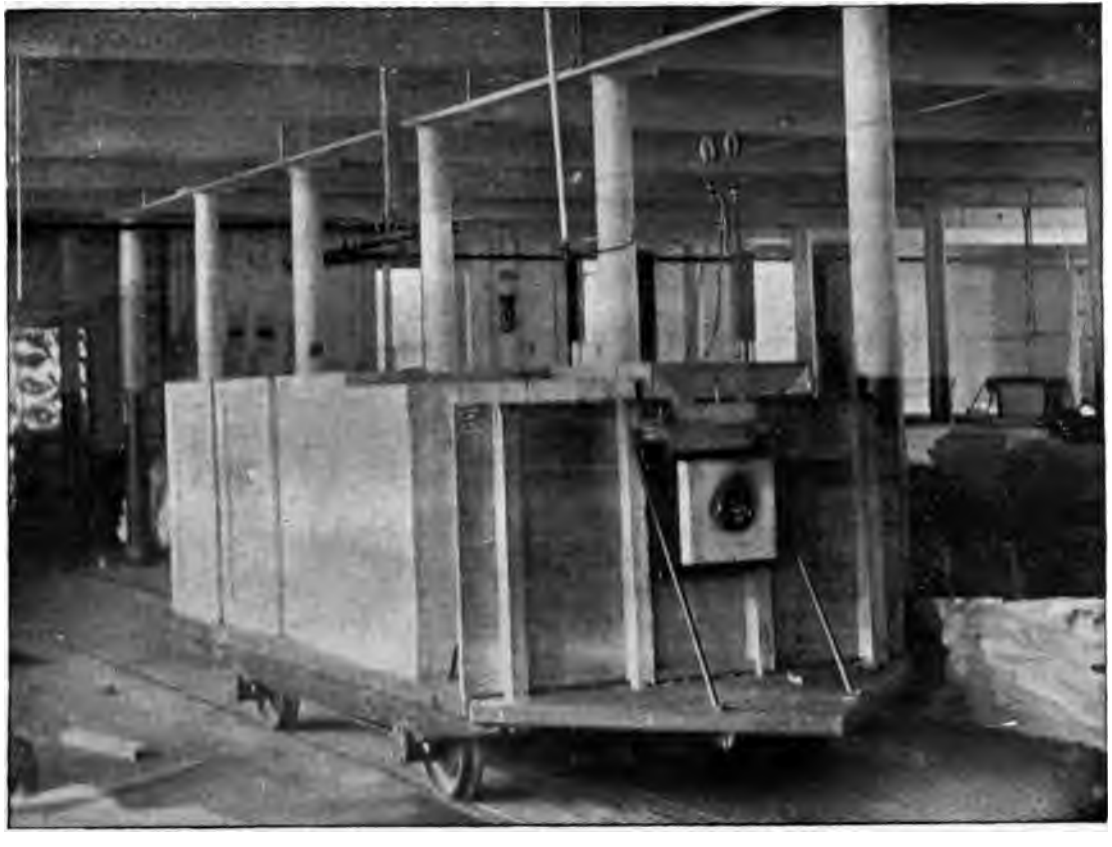

Fig. 2. Electric Motor Car at Tremont and Suffolk Mills, Lowell, Mass.

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Fig. 3. Electric Motor Car at Salmon Falls Manufacturing Co., Salmon Falls, N. H.

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Fig. 4. Electric Motor Car at Washington Mills, Lawrence, Mass.

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Fig. 5. Electric Motor Car at Thomson-Houston Electric Co.'s Factory, Lynn, Mass.

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Fig. 6. Electric Motor Car at Nashua Manufacturing Co., Nashua, N. H.

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The tram-road at the Washington Mills, Lawrence, Mass., is used entirely for the transportation of coal. The motor car, in this case, is used as a locomotive and is capable of hauling a load of five thousand pounds. The illustration (Fig. 4) shows the car while making one of its trips in the yard.

A tramway was early put in use about the factories of the Thomson-Houston Electric Company, at Lynn, Mass. The track runs in and about all of the different factory buildings and yards, and abounds with curves, some of which are twelve feet radius, and grades, the maximum reaching fourteen per cent. This heavy grade is easily climbed with the greatest loads. Three motor cars are constantly in use, and the work of the factory is facilitated by them in a marked degree. The illustration (Fig. 5) shows one of the smaller cars in the yard.

Among the later tramway installations may be mentioned two roads at the Nashua Manufacturing Company, Nashua, N. H., and one at the Jackson Manufacturing Company, Nashua, N. H. Of the two located at the Nashua Manufacturing Company, one is used for transporting finished cloth from the cloth room to the storehouse, while the other is used for transporting cloth, as delivered by the mill, to the cloth room.

The former road consists of about one thousand eight hundred feet of standard gauge track (4′ 8½″) and is laid with T rails. The platform of the motor car is twelve feet long by eight feet wide, and is roofed so as to afford protection from rain or snow. The truck is equipped with two motors of three horse-power each. The illustration (Fig. 6) shows this car loaded and making a trip from the cloth room to storehouse.

The other road consists of about one thousand feet of thirty-six-inch gauge track. The platform of the motor car is ten feet long by four and one-half feet in width. This truck is equipped with one three horse-power motor. The illustration (Fig. 7) represents the car loaded with cloth.

The Nashua Manufacturing Company has also placed in its wheel-room a generator of sufficient size to operate both tram-roads; this generator is cared for by the regular wheelman.

The road located at the Jackson Manufacturing Company's mills is equipped with the double overhead trolley system. It is placed in the cotton storehouse and consists of about three hundred and fifty feet of forty-eight-inch gauge track. The platform of the motor car is twelve feet long by seven feet wide. The track is equipped with one three horse-power motor, this car being used for handling cotton in bales. The illustration (Fig. 8) represents the car when loaded with cotton, and also shows the form of double trolley used in this installation.

At Whitinsville, Mass., the Thomson-Houston Motor Company is installing an electric road for freight service. The track is about one and one-quarter miles in length and extends from the shops of the Whitin Machine Company to the New York, Providence & Boston R.R. at Whitins station, connecting with that road. There is to be operated upon this road an electric locomotive of sixty horse-power capacity, having sufficient power to haul two loaded freight cars, weighing one hundred and twenty thousand pounds, at a speed of six miles per hour, and also having power enough to start this load on a three and nine-tenths per cent. grade, if necessary. A generator of eighty-five horse-power capacity has been placed in the machine shop of the machine company and is driven from their main line of shafting.

The above briefly describes a few of the roads that can be seen at any time in successful operation.

The third head to be considered is the application of electricity to hoisting apparatus.

For hoisting work, machines are now made of almost any size and power, from the three horse-power whip, suitable for handling light loads at a high rate of speed, to eighty and one hundred horse-power machines for heavy work. A description of the fifteen horse-power hoist manufactured by the Thomson-Houston Motor Company may be of interest to you.

Fig. 7. Electric Motor Car at Nashua Manufacturing Co., Nashua, N. H.

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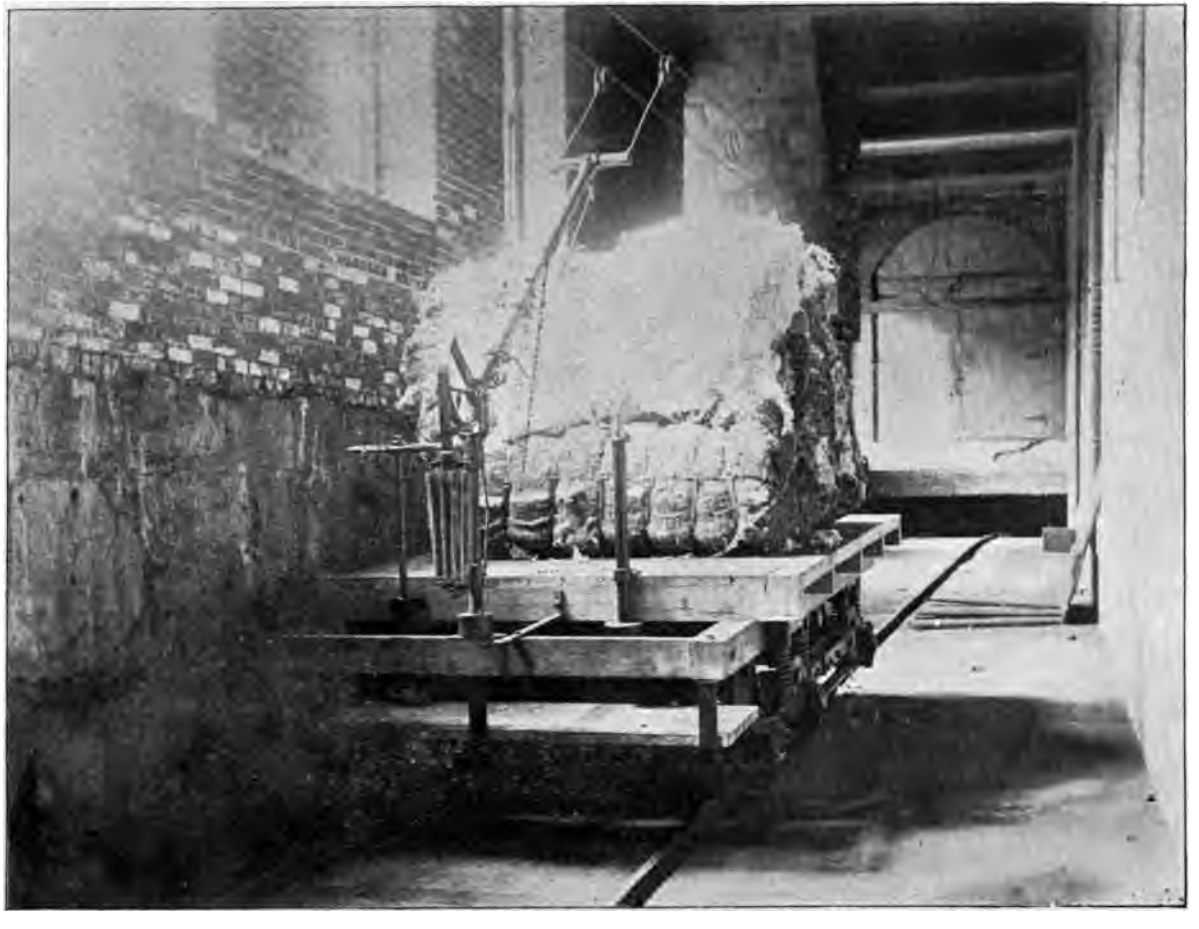

Fig. 8. Electric Motor Car at Jackson Manufacturing Co., Nashua, N. H.

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It combines a fifteen horse-power specially wound motor and a drum hoist. The outside dimensions of the entire machine are fifty-six and three-eighths inches by fifty-four and three-eighths inches. The motor shaft carries a small pinion which engages the first large gear wheel. This, in turn, carries a small pinion on its shaft which meshes into the large gear wheel of the drum. The total speed reduction from the armature shaft to the drum is twenty-nine and one-tenth.

The friction clutch consists of a stout band of steel lined with small friction blocks made of wood. The movement of the clutch lever tightens this band upon the drum. The connection becomes, for the time being, positive, but possesses the advantage (and this is where any form of cone clutch is weak) that the disengagement is equally positive, and all danger of the clutch sticking, and consequently winding up of the drum too far, is avoided The length of the controlling arm gives tremendous leverage, and slipping is practically impossible.

The speed of the motor, and, consequently, of the hoist, is under control through the rheostat, which is placed entirely out of sight under the bed plate. The segments are connected to the contact board on the side, and the rotation of the contact arm is controlled by rack and pinion. This arrangement does away with a heavy rheostat arm, requiring much muscular effort in its operation, and substitutes an equally effective while much easier operated controlling device. The reversing switch when used is conveniently placed next to the rheostat contact board. The brake, consisting of a heavy iron band extending almost entirely around the drum circumference, is operated by a foot lever.

Fig. 9 gives a general view of this hoist, while Figs. 10 and 11 show end and side views of the same machine.

These hoists are particularly desirable for storehouses and warehouses, because they can be mounted upon trucks and easily moved from one portion of the building to the other, wherever needed. A plant of this description is in use on one of the large docks in Brooklyn. The wharf is wired in all parts, plugs being inserted at intervals so that the supply of

power can be obtained from the main wires at almost any point and at a moment's notice. Flexible wires are used between the mains and the hoist motor for conducting the current.

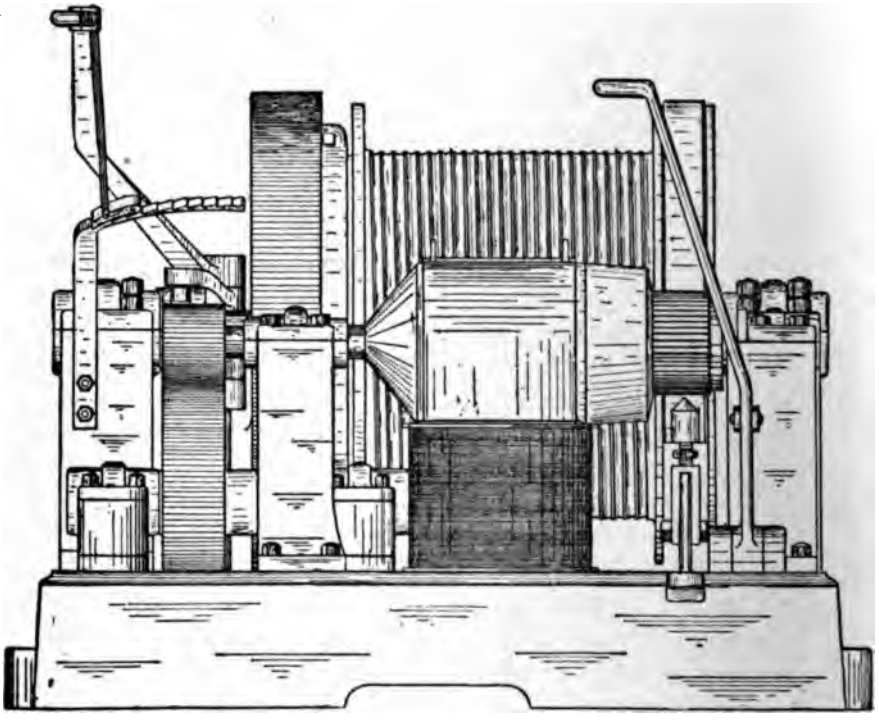

Fig. 10.—Electric Hoist, Front View.

On Constitution Wharf, in Boston, a large forty-five horse-power motor is used to drive an elevator and also a long line of shafting running the entire length of the building, from which four friction whip hoists are operated. These whip hoists are used in handling light loads rapidly. They are comparatively inexpensive and do away with dummy engines, or of a horse at one end of a rope, slowly pulling up a barrel or bale at the other end, consuming a great deal of time, patience and money. These small friction whips, after the design used at Constitution Wharf, should receive the approval of mill men for use in cotton, wool, or cloth store-houses. To-day, in a great many places, a dozen or more

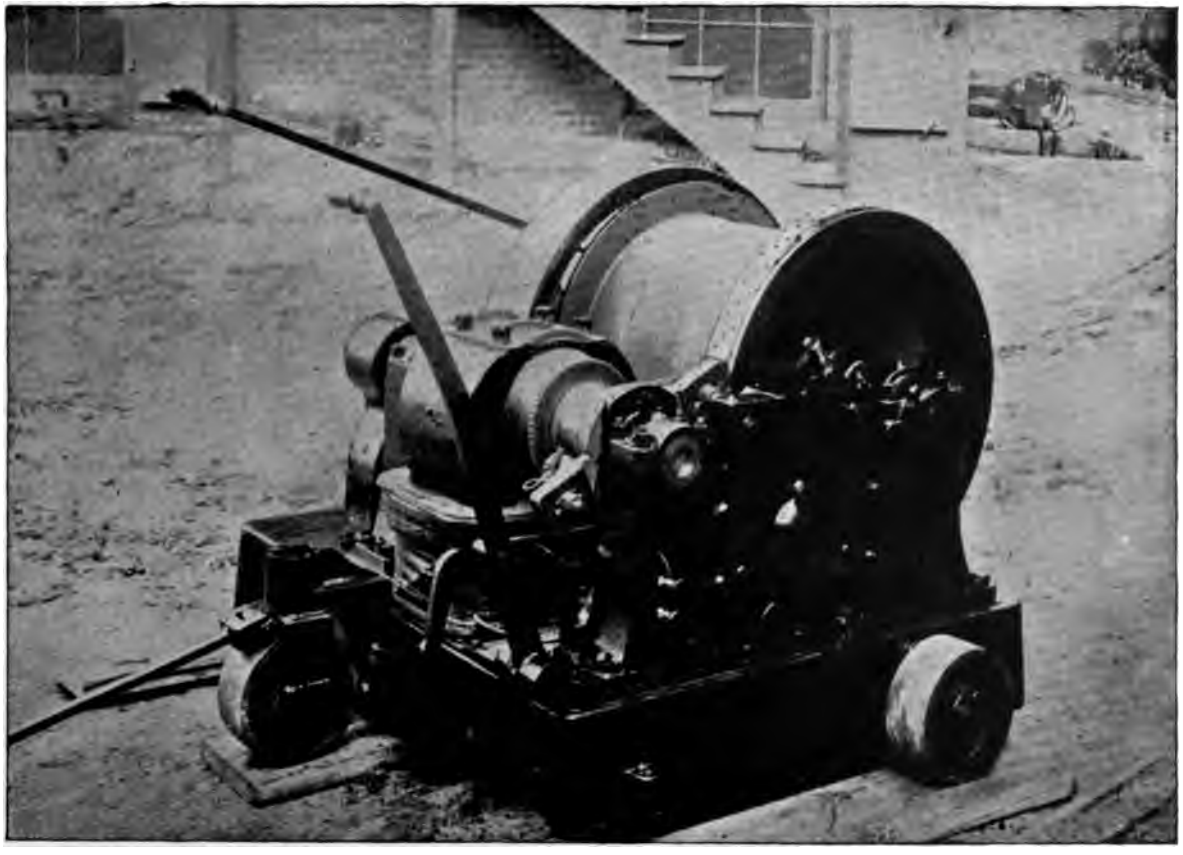

Fig. 9. Electric Hoist.

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men are required to do the same amount of work that two men with a whip hoist could perform more quickly and easily.

An arrangement has been designed by the Thomson-Houston Motor Company in which a travelling overhead trolley carriage is used in connection with the friction hoist. With this arrangement a load can be picked up at one part of the storehouse and deposited in another part at any height desired.

It might be well to again press upon you the fact that the freedom from danger of fire is a great point in favor of electric hoists, especially where cotton and wool are to be handled.

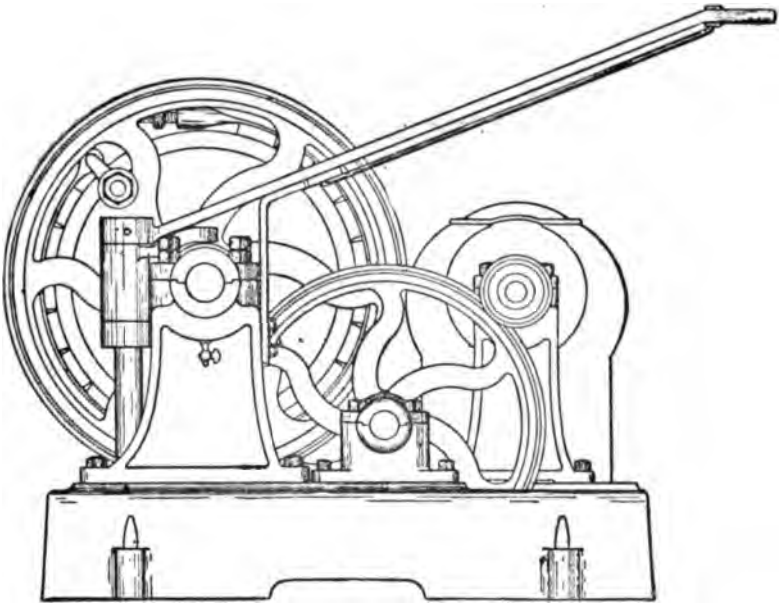

Fig. 11.—Electric Hoist, Side View.

Within the past year electricity has been applied successfully to elevators. The Thomson-Houston Motor Company has designed a machine for this special work. The hoisting drum is mounted upon the same bed plate as the motor, and is driven by means of worm gearing. The worm shaft is connected directly to the armature shaft by a coupling, insuring positive motion between the motor and hoisting drum.

The principal feature of the machine, however, is the fact of the motor being so controlled, by means of a suitable controlling device operated from the car, that it is made to revolve in either direction, running the car up or down as desired.

As the motor is entirely at rest when the elevator is not in use, it consumes no power except when the elevator is actually running. A saving of power is hereby effected in this form over any form of belt machine which can be used. The electric elevator can be operated at any speed, from the slowly moving freight elevator, running at a speed of fifty feet per minute, to the rapidly moving passenger machine, running at a speed of three hundred feet per minute.

The fourth and last head to be considered is the application of electricity to power pumps.

While the question of adapting electricity to pumping may not have so much interest to mill men in general as the previous points brought up, still it may be of sufficient interest to warrant bringing to your attention a form of pump which is being used to a great extent by the Thomson-Houston Motor Company in connection with its motors.

This pump is manufactured by the Gould Manufacturing Company, of Seneca Falls, N. Y., and is of the triplex, single-acting type. Three single-acting plungers, with their cranks hung from the main shaft at one hundred and twenty degrees, are worked in three vertical cylinders. Fig. 12 shows the general appearance of this type of pump.

This arrangement is the best possible one for electric work, as it insures an almost constant load upon the motor at all points of the stroke. The Gould Manufacturing Company makes pumps of this design, in all sizes, from two-inch by four-inch cylinders for light work to twelve-inch by twelve-inch cylinders for heavy work. Larger pumps than the latter size are in course of design.

The table of tests given below shows the efficiency of the Gould eight-inch by eight-inch pump when operated by a fifteen horse-power motor. As shown by the record, the efficiency of the electric power pump is fully equal to the steam-

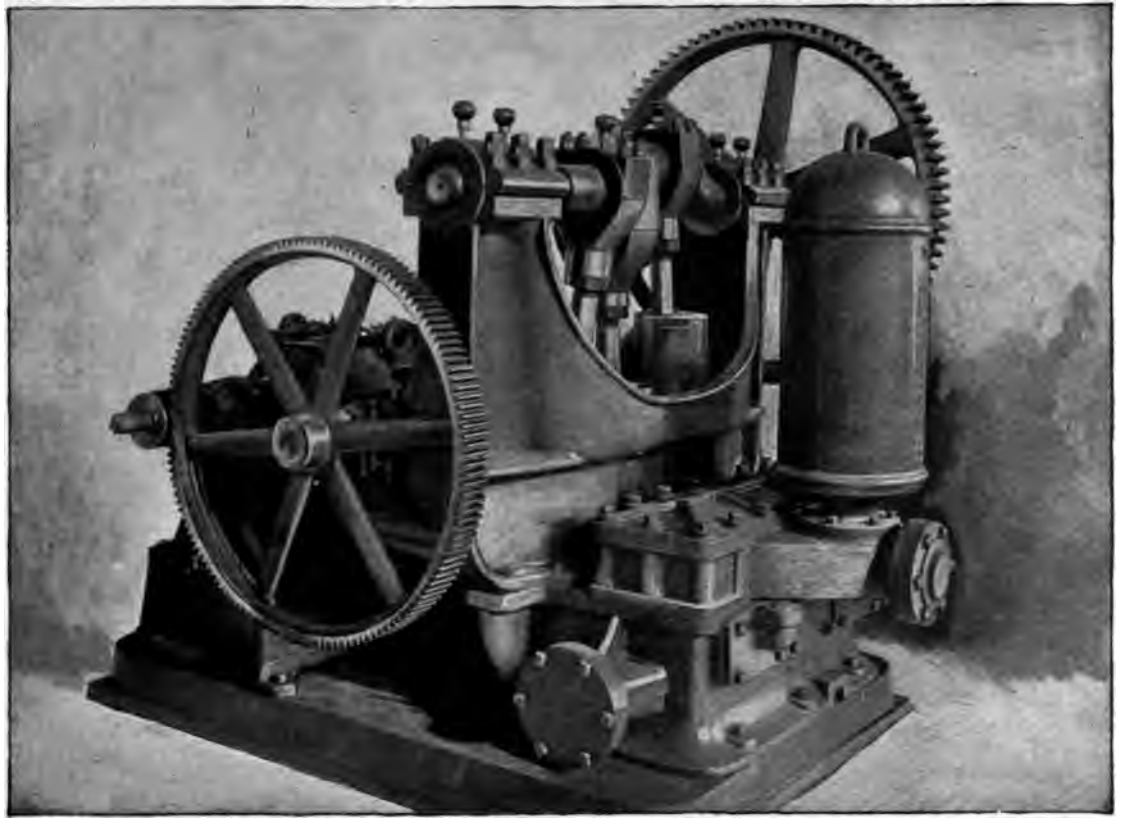

Fig. 12. Electric Power Pump.

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pump of corresponding capacity and working under similar conditions.

Tests on Gould Pump, July 31, 1890.

Pressure, lbs. per square inch.	Gallons per Min., . .	100	125	150	175	200	225	250
	Electrical H. P., .	1.2	1.5	1.8	2.2	2.7	3.3	3.9
0	Mechanical H. P., .	.12	.16	.18	.21	.23	.26	.26
	Efficiency, . .	.10	.10	.10	.10	.071	.071	.072
	Electrical H. P., .	2.91	3.67	4.16	5.06	5.87	6.56	-
20	Mechanical H. P., .	1.38	1.74	2.09	2.42	2.83	3.10	-
	Efficiency, . .	.48	.47	.50	.48	.48	.47	-
	Electrical H. P., .	5.16	6.52	7.75	8.98	-	-	-
50	Mechanical H. P., .	3.11	3.95	4.75	5.62	-	-	-
	Efficiency, . .	.602	.606	.612	.615	-	-	-
	Electrical H. P., .	7.30	8.64	10.48	-	-	-	-
75	Mechanical H. P., .	4.69	5.79	7.06	-	-	-	-
	Efficiency, . .	.643	.670	.674	-	-	-	-
	Electrical H. P., .	9.21	11.54	12.25	Speed of Pump, 27 revolutions.			
100	Mechanical H. P., .	6.16	7.77	8.36				
	Efficiency, . .	.670	.673	.682				
	Electrical H. P., .	11.29	13.88					
125	Mechanical H. P., .	7.74	9.37					
	Efficiency, . .	.686	.675					
	Electrical H. P., .	14.02	15.16	Speed of Pump, 22 revolutions.				
150	Mechanical H. P., .	9.17	10.19					
	Efficiency, . .	.654	.672					

43806

The smaller sizes of this pump are particularly adapted for fire purposes as they can be distributed in different parts of the mill, power being carried to them by wires from the generator. They are always ready to be operated, and because of their small size can be placed in such a position as to be entirely out of the way of the every-day operations of the mill. Also, electric power pumps are intended to supersede steam-pumps of any size, particularly if the location of the pump is

any great distance from the source of power. With the efficiency the same, the electric pump can be operated much more economically, owing to the small loss in power experienced in transmitting electricity as compared to the loss in transmitting steam an equal distance.

The advantages of the electrical system of power distribution in regular work has been shown to be as follows: —

It permits the utilization of water-powers situated at distant or inaccessible points. In the absence of water-power, electric transmission renders a concentration of steam plants possible. Small, expensive and perhaps troublesome steam plants are done away with, and in their place is a large, well-equipped and economical central station from which the required amount of power, with small loss, is conveyed to the different motors, wherever placed.

The PRESIDENT. Does any one wish to discuss any point of this paper?

A MEMBER. I would like to inquire about the safety of electricity in and about our mill yards, and as a representative of the insurance companies is present, and we are all his humble subjects, I will call on Mr. Atkinson.

Mr. ATKINSON. Mr. President, I will remark that when the electric light was first introduced it became apparent at once that it was one of the new risks that we were obliged to take into account. The first electric light company, zealous and eager, and perhaps justified in their eagerness, set up their plants in the worst manner. Twenty-three fires in the first year, fortunately without great loss, have made clear to them, as well as to the underwriters, the danger of being over-hasty. That plant has been made safe. The first installation of electric power for other purposes was made in a dangerous manner. It was first proposed to introduce a single trolley track, and one plant at least had to be completely altered, and there appeared the same prospect of danger from the single trolley track that had appeared from the naked wire in the electric lighting. It is clear that the transmission of power by electricity is one

of the coming powers which the underwriters will be called upon to adjust themselves. It will become expedient and necessary in your mills and may be made entirely safe, but I caution you all not to go too fast, and be sure that every point has been investigated and that your plants are adjusted in the right manner. Certain rules have been established as the result of experience, and I have no doubt that the Thomson-Houston Company and other companies will adjust their plants to those rules, but I give you one caution: not to permit a single trolley track to come into your mill yards, but if there is a single trolley wire near your mills be careful that none of your wires that have any connection with your mill yards come anywhere near that wire. That is all I can say at present, but I will say that you will find it profitable to use electricity and that it can be used safely, but you must be careful and not proceed in accordance with the eagerness of those who fail to see all the hazards but see all the profits.

Mr. Hussey. There is one thing I would like to ask Mr. Atkinson, and that is this: From what particular point in an electric overhead system does he apprehend danger from fire, particularly when the load itself is entirely out of doors, the wires are entirely separate from any buildings, and further, where by the methods of insulation to-day used by all first-class electric companies in case of a short circuit, that is, in the case of a broken wire of a trolley, that the instruments and fuses are so made as to blow out and immediately shut out all possibility of the current running to the machine? I will agree that in mill inside work it is perhaps better to have a thoroughly insulated system, because of the danger which I stated, of the liability of sparking the current between the rails. With a thoroughly insulated system I cannot see how there is any more danger from sparking or fire than from the use of gas or oil, or anything that is used now in a mill.

Mr. Atkinson. I shall be prepared to answer the question when the matter has been so long investigated that it will be no longer necessary for the electric companies to

take the precautions to overcome the known dangers. I can only now caution you not to incur unknown dangers without investigation. I cannot answer the question here without a discussion of the whole subject, only I express the profoundest distrust of the single trolley system. I do not know that you have disregarded the danger. It is not necessary for you to aid them by experiments in your mills. When we are sure it is safe, then I will answer the question. At present I do not think the safety of the single trolley wire is assured, and I want you to keep your telephone and trolley wires as far as possible from any single trolley wire as a mere precaution.

The PRESIDENT. The next remarks will be by Mr. Atkinson, on "Food and Feeding in Relation to Wages."

Mr. ATKINSON. I have not come here to inflict a long paper on you. There is one thought that has occurred to me which I will present now. Well-prepared papers are of extreme value, as thorough and as complete as those that have been submitted to-day, but on the first reading they make little impression upon the mind, and I would therefore suggest that such papers might be called for to be submitted to the Board of Government a month in advance of the meeting, and be printed and distributed and made a subject of interesting discussion at the meetings, rather than to have a complete reading, and I think that will add life and interest to the meetings, which I know by experience cannot be excited by merely reading a paper, however thorough it is. I have learned long ago where I could trust myself to do away with the manuscript and to speak instead of reading.

Now I have prepared, as I thought it better to prepare, my own report of this subject, which I believe is one of very great importance. I do not propose to read it. I shall simply give you a digest of it and then give you something to digest afterwards, and which will prove the most appetizing will be proved afterwards, after you have been subjected to both treatments. I will run hastily over these points and turn over the manuscript to the reporters.

FOOD AND FEEDING CONSIDERED AS A FACTOR IN MAKING THE RATE OF WAGES OR EARNINGS.

By Edward Atkinson, Boston, Mass.

It is fortunate for the people of this country that in treating the food question we may deal with waste rather than with want, with abundance rather than with scarcity; yet I am far from certain that the evils which ensue from the waste of food are not greater than many of the evils which come from scarcity, if that scarcity falls short of absolute want. Scarcity is a good school-master. It tends to right methods of nutrition. Witness the economy of food and the nutritive quality of the food in France. Scarcity tending to an approach to famine, like that which now prevails in some parts of Italy, is to be deplored, especially in view of the fact that it is due to the enormously excessive taxation rendered necessary in order to maintain the liberty of the kingdom

The evils coming from scarcity which falls short of want may be remediable under the pressure of necessity, but the evils which come from the waste of an excess of food may require one or two generations for their remedy.

You may observe that the nutrition of animals — of horses, cows, beeves, sheep and pigs — is pretty well understood. You may remark that when beasts get out of condition we treat them mainly by altering their diet; but when a man gets out of condition he is apt to treat himself with *pills*. Perhaps the surest way to make a great fortune is through the concoction of quack medicines, provided the quack is a master of the art of lying and possesses enough capital to give a wide circulation to his first batch of lies and of false statements of the cures that he claims to have accomplished.

I remember hearing Dr. Oliver Wendell Holmes once make a remark, which has been a comfort to me all my life, to this effect: "The law of nature is to cure and not to kill, provided you will help her." Then he went on to explain how much injury was done by false attempts to help. He had taken the statistics of the sales of medicine by apothecaries with the results that about twelve and one-half per cent. were on the prescriptions of physicians; about eighty-seven and one-half per cent. were doses which men ignorantly took on their own motion, or at the prescription of quacks. When the simple facts about the art of nutrition shall become a part of the common knowledge of the people, we may hope that the compounders and vendors of anti-bilious pills and other noxious nostrums will speedily become bankrupt.

I was led into this study a few years ago by the compilation of the statistics of the cost of living. When these figures disclosed the fact that the mere cost of the materials for food, even in this land of huge abundance, absorbs one-half the income or more, of nine-tenths of the people, I was greatly startled. I suppose that I then knew about as much as most people about what food is.

What is it? Suppose I put that question to you. What is food? I doubt if there are five persons in this room who would give an answer to that question that would possess even an approach to accuracy, except by chance. If you answered seriously, you would reply, Why, of course, meat, grain and vegetables are food. So they are in one sense, but not in a true sense. Is raw meat food for man? Is unground wheat food for woman? Will you feed your children on raw potatoes or turnips? Food material is no more food than raw cotton is cotton fabric.

Now when you have brought cotton, wool and dyestuffs into your works what do you do with them? Do you not convert them by the finest and most scientific processes of mechanism known to you? Do you not apply heat under the most careful regulation? Do you not attempt to control the humidity of the atmosphere? And when you have woven

the cloth do you not require the most accurate application of the science of chemistry in your bleaching, your dyeing and your printing? Do you not devote the utmost care to the maintenance of your machinery and to sustaining your works in the most effective condition?

Let me ask you a plain question. How much science is applied to the maintenance of the men and women without whose careful and assiduous attention all your fine mechanism would be of no avail? Of course I do not mean to charge you with any admitted neglect. You may put the question nearer home. How much science is applied to the conversion of crude food material into appetizing food in your own houses? Do you know as much about the food and feeding of your own families as you know about the food and feeding of your horses and your cows? The true art of nutrition has hardly begun to be known, and what you do not practice, of course you cannot promote.

Let us consider this matter a little by way of comparison. As I have said to you already, you call to your aid the masters of every science in order to enable you to provide each inhabitant of this country with about five dollars' worth of cotton fabrics every year. I think our population numbered nearly sixty-five million last year. In any event it reaches that number now. At five dollars per capita the value of all our cotton fabrics — brown, bleached and printed — would come to about three hundred and twenty-five million dollars. I doubt if the census of 1890 will show quite as much.

If I were to say to you that fifty dollars a year expended for food material, might be so converted by the right application of heat into nutritious food as to give the great majority of the people of this country better and more adequate nutrition than they now get; if I were to put the standard of adequate nutrition of the men and women who work in your factories at a necessary cost for the material of only a dollar a week, cooked and ready for consumption, you would say, Well, I wonder what absurd theory Atkin-

son will give us next. You have already said that in your inner consciousness, if you have not said it out loud, a good many times. Who has come out ahead, the theorist or the practical man? I tell you that complete and adequate nutrition can be supplied to the average man and woman working in your factories at a cost of not exceeding one dollar a week for the food material and the fuel to cook it with. But perhaps it may not pay to try to work at so very low a cost — it may require too much time.

Now by comparison, you furnish the people of the United States five dollars' worth of cotton goods a year, and that suffices for them. At only a dollar a week per capita or a little less, or fifty dollars a year, the food bill of the people costs them *ten times as much as the supply of cotton fabrics that you furnish them*, out of which about half of their clothing is made. Sixty-five million of population consuming fifty dollars' worth of food material each, in a year would spend three billion two hundred and fifty million dollars ($3,250,000,000). The cost of food and fuel is in fact nearer double that amount than any other figure, especially if you add the liquor bill to the food bill; and the waste of food, for lack of any sort of scientific treatment of this art of human nutrition, and for the lack of any sort of popular knowledge in respect to the right application of fuel to food and feeding, — I say *the waste only* comes to more than the entire value of all the textile fabrics made in all your factories, cotton, woollen, worsted and shoddy combined.

What can you do about it, some of you ask. Presently I will show you. Let us begin with the waste of fuel, although that is the least important matter. The man who can save you a quarter of a pound of coal per horse-power per hour on the present consumption of fuel under your boilers would have his big fortune well assured, and yet I feel very certain that our ignorance of the right method of converting coal into power or work may be measured by the height of your chimneys and the strength of your drafts. The next pestilent inventor who comes along and shows you the right

way to convert your coal and water combined into fuel gas, which may be completely consumed without any draft, may leave your big chimneys useless except as monuments of the ignorance of the present generation. You may put that in your pipe and smoke it, but you will not smoke your chimneys any more after five, ten, fifteen, twenty years, more or less. Yet we think we know something about the saving of fuel in making steam as compared to what we knew a few years ago.

So we do, but now go into your kitchen. You will find that we consume a pound of coal, more rather than less, to every pound of food material that we subject to its malignant influence in an over-heated iron stove or range, in the processes which are now miscalled cooking. It is not true that it was "the Lord who sent the food and the devil who sent the cook;" it is the Lord who sent the food and the devil who sent you the stove. Is it not so? What more infernal place of dwelling can you find than a small kitchen containing a big stove working away under a strong draft in midsummer? I won't use any swear words, but I think they might be well applied to such a place.

Now I can cook fifty pounds of bread, meat and vegetables in the most perfect and nutritious manner with two pints or two pounds, or a little less, of kerosene oil, burned in the ordinary Rochester lamp under my Aladdin oven of the standard size.

One of my customers, a leading patent lawyer in Pittsburg, does substantially all the cooking for a family of five persons in one of these ovens, under which he burns the natural gas. He pays fifteen cents per thousand feet for the natural gas, and he burns one-third of a thousand feet per month. He estimates the cost of fuel for cooking for his family of five at sixty cents a year. The next thing on the cards will be fuel gas distributed among our dwellings, perhaps not at fifteen cents a thousand, but suppose it is fifty, then what? At fifty cents a thousand, one-third of a thou-

sand per month for five persons would make the cost of fuel for cooking just two dollars a year.

Now see what a waste of energy there is in burning even two pounds or two pints of oil to fifty pounds of food. I only catch that part of the heat which comes out of the top of the chimney. I shut that up in a paper box and make it do some work, but I lose all the rest. But compare even what I have accomplished, one pound of oil to twenty-five pounds of food, with the consumption of coal in your stoves at the rate of a pound of coal or more to every pound of food.

Now, gentlemen, if you require light, air, ventilation, uniform humidity, regular and continuous speed, and the most perfect conditions in all the mechanism of your factories, do you not also require health, strength, clear heads, ready wits and prompt work in the men and women who operate the machines? Can you expect such qualities from cold victuals and pale pie bolted hastily in the noon hour, as I have seen it when I have passed through some of your works? Do not these several factors of health, aptitude and ready observation, which are necessary to the production of first-class fabrics from the sale of which both the wages of the workmen and the profit of the owner are alike derived, depend wholly upon the suitable shelter, the adequate nutrition and the wholesome conditions of living on the part of those who tend the machinery?

The first lesson in the insurance business which must be learned by those who inspect factories is to hold their tongues on everything that does not concern the safety of the factory, but we keep our eyes open. I have more than once been puzzled by the varying results of different factories, which were apparently fitted with the same kinds of machinery and which were operated in the same way. Not until I had made an inspection in my insurance work could I explain the profit of one and the loss of another. In some cases which I might name, I am very sure that I discovered the open secret of non-success. It was in the poor quality,

the bad position and the bad condition of the dwelling-houses which were occupied by the operatives.

You are all familiar with the rule that the highest rates of wages that can be derived from the market price of any given product are secured by those who make that kind of goods at the lowest cost per pound or per yard of cloth for the labor, other things being equal. The most skilful workmen, the weavers who have the greatest aptitude for their work, and others in corresponding departments, gravitate almost in spite of themselves to the best equipped factories, because in such factories they can turn off the greatest quantity of work by the piece with the least amount of effort. They earn the highest wages for themselves, while the cost of labor is diminished through their skill and aptitude. Now, will capable men and women who have a clear conception of the merit of the factory in which they desire to work be willing to live in badly situated, badly constructed and very crowded dwelling-houses? Surely not.

If ever the conditions of shelter may thus affect the profit and loss account of the factory, how much more may the conditions of the food supply, the fuel of the human boiler, affect the capacity of man or woman to do the best work. The great contractor, Brassey, long since found out and published the fact that the well-fed and highly paid British navvy was a less costly man to employ in building railroads on the continent of Europe or anywhere else than the under-fed working people of the country through which the railroad passed.

Professor Atwater has lately given great attention to the science of nutrition. I shall presently refer to his work. In dealing with the dietaries of different classes of people he struck two bodies of workmen who appeared to be consuming about double the standard ration of a German soldier when on a forced march. He thought there must have been an error; but in each case he traced that dietary to a brick yard, — one in Massachusetts and one in Connecticut, — of which the owners had found out that the right way to make

the biggest tale of bricks was to stuff the workmen with all the beef they could eat of the best kind, and they converted double the ration of a German soldier on a forced march into bricks.

It was the scientific nutrition of the German army that gave the great strategist, Von Moltke, the power to move his troops with the precision of a great machine. It was the potential energy in the German sausage, made of condensed meat, peas and other muscle-producing food, readily converted into nutritious soup whenever the troops encamped, that proved more than a match for the French rifles, even though the Frenchmen know something about food and feeding.

I said in the beginning that if I were to put the question to you, What is food? very few of you would make a reply that would possess any close approach to accuracy. A complete food must contain definite proportions of proteine, or nitrogenous material, which is assumed to be assimilated in the process of making muscular fibre; of starch, or carbohydrate, and of fat: the latter is assumed to be mainly consumed in keeping up the heat of the body. Food may be abundant, but if it does not contain these ingredients in the right proportion men may be starved even on an abundant food supply. I do not name the mineral salts, because they are found in due proportion in almost every dietary that man may purchase.

These blocks which I present to you indicate by their size the relative proportions of the different elements necessary to the nutrition of the human body. But these chemical elements must be developed or converted from their crude form by the application of heat into a condition in which they can be assimilated by the human body. If they are not treated or converted in the right way, they may not be assimilated; they may promote dyspepsia and disease without imparting sufficient nutrition even if abundant.

Professor Atwater has converted the chemical elements of food into mechanical units of heat, named in science

Calories. We may take a Calorie as the unit of nutrition, and a very convenient one it will be found, as I will presently attempt to show you. A working man occupied in moderate work must have four thousand Calories a day, of which he must assimilate about nine-tenths. These Calories must be derived from food which will yield starch in the proportion of three, nitrogen in the proportion of one, and fat in the proportion of one; say twenty-four hundred Calories derived from starchy material, eight hundred derived from nitrogenous material, eight hundred derived from fat.

These elements being established, it becomes a perfectly simple matter to compile a table of one hundred pounds of food, — meat, grain and vegetables, — to sort it chemically in the right proportions, in such a way that each pound will yield twelve hundred Calories. It follows that if a man buys three and one-half pounds of such food in due proportion every day, and cooks it in a proper manner, he will be fully nourished, and will waste very little.

I am engaged in compiling these tables. I have employed different people to get the prices at retail of grains, — oatmeal, corn meal, etc., — of bread, vegetables, roots, sugar, fish and meats, in different parts of Boston. I shall presently have these tables in form so that any one can make use of them. The man who can afford to buy the cheapest kinds of meat to be eaten with the best kinds of bread, grain and vegetables will be able to buy at the rate of one hundred pounds of food per month at three and one-half cents a pound, each pound yielding twelve hundred Calories. That comes to fourteen cents a day, ninety-eight cents a week. He will be fully and adequately nourished if that food is properly cooked. It can be properly cooked in the square oven, of which an example is before you. It can be properly cooked in these cooking pails of different kinds, from which I shall presently give you a taste of what I call "the glorified hash," made of the cheapest and toughest parts of meat.

There may, however, be very few persons who can afford to give the time to the selection of food which may be necessary in order to live at a dollar a week. Then one may take the medium qualities of meat combined with the best qualities of fish, grain and vegetables, and without any amount of trouble, care or attention one dollar and a half will cover the bill. If, however, you buy the best kinds in their season, of course without luxurious extravagance, like canvas-back ducks and tenderloin beef, two dollars a week covers the bill. Anything beyond two dollars a week spent in the nutrition of a man at active work is either spent for absolute luxury, or, what is the common practice, *for absolute waste.* The tables which I have prepared have not yet been completely and scientifically analyzed. By the time this address goes to press I shall be able to put them into this address.

Now I ask you a plain question. If the food of your operatives is badly selected and badly cooked, can you expect it to yield the potential energy, either mental or manual, which your work calls for? Will not your work of carding, spinning and weaving suffer from bad nutrition of your operatives? Have I any evidence that it does suffer? Not much; but there are some indications that have lately come under my observation which certainly squint in that direction. What is called industrial insurance — not these bogus assessment companies, but genuine life insurance, granted in small amounts on weekly or monthly payments, — is comparatively a new feature in this country. It has been taken up by one or more of the safest and most reputable life insurance companies.

There is an insurance company called the Prudential of London, doing a business of which the figures are almost incomprehensible. Now it has lately been stated to me by the medical adviser of one of these companies that they already have reason to regret that they placed agents to solicit insurance on the lives of some of the factory operatives in some of the cities of New England. They

are poor lives, and if they are poor lives it is due to poor living; and if due to poor living, will not those who live poorly do poor work?

If the average of life and health is lower than in other occupations and other places, lower in some factory cities than it is in others, what is the reason? Is not the modern factory one of the best lighted, best ventilated and most wholesome places in which men or women can work? Has not the "devil's dust," as it used to be called, been almost wholly removed from almost every department? Is it not true that in the greater part of your work, in order that the cotton may spin properly, you require fresh air, a relative humidity of about seventy-five, and about seventy degrees of heat? Is it not true that the best atmosphere for the spinning of cotton is that in which plants thrive best?

If human beings do not thrive under these conditions, when the work is not such as to impose any excessive strain upon the human body, what other fault can be found than fault with the mode of living? In other words may not the "poor lives" be due to bad food and bad feeding? This is one of my theories, a somewhat hasty generalization based on a statement which I have not yet verified, but it goes without saying that such may be the facts. Whether it is worth while for you to take up this question, or whether you will pass it by as a fad and not a fact, rests with you.

If there is a remedy within your reach it must be one that you can justify, not only as a matter of humanity but as a matter of profit. Will it pay to deal with the nutrition of your operatives, and to show them the way by which they may learn to nourish themselves adequately, completely, and in a most appetizing manner, at less cost than they do now? I think you can do this if you will, and I think you can make it pay, if not in one way, then in another.

In a rough-and-ready way I have made the following computations: If you can set apart a suitable room, one hundred feet long by fifteen feet wide, with a long table, which ought really to have a marble top or a slate top that can be kept

clean without any difficulty, one hundred persons can be seated comfortably at such a table, fifty on each side. Next to this you may provide an apartment one hundred feet long and ten feet wide, furnished with washing apparatus, one end set off for a smoking-room. Of course all this must be outside of your main factory building, where smoking cannot be permitted, — the rest of this room to be devoted to cooking. That would make twenty-five hundred feet of floor surface. If it were in the mill it would cost seventy-five cents a foot. In a separate building it might cost one dollar a foot, twenty-five hundred dollars.

Either in the dining-room or in the side room a range of Aladdin oven boxes can be set upon brackets, each with a very small gas jet burning not over one foot of gas per hour, perhaps less, underneath the box. Each man or woman who applies for the right to make use of this room may then bring two boxes of food material prepared to be cooked and one box of coffee or cocoa. These boxes may be brought in a wire frame which can be set into the Aladdin cooking box on reaching the mill; turn on the gas, light it, and at twelve o'clock a hot dinner will be ready, — appetizing and nutritious.

A capital of three thousand dollars will cover the entire cost of a plant that would accommodate one hundred men and women. Will it pay? Are there not enough men and women among your best and most intelligent people who would pay three dollars a year, twenty-five cents a month, for the privileges of using the premises? If so, that would yield a gross income of ten per cent. on your investment. Whether or not that man or that woman would earn higher wages and make goods at lower cost, I leave to the future to determine, if any of you adopt this theory and put it into practice.

You can begin with ten as well as with a hundred. Will it pay?

ADDENDA, TAKEN FROM AN ADDRESS LATELY GIVEN IN NEW YORK.

As a rule the food of men and women is served without the slightest attention to proportions or to waste, following only under the pressure of necessity a sort of blind instinct. I do not propose to bring each man or each woman to a measured quantity every day; that would be very foolish to undertake; but may there not be certain broad and general rules, which when once laid down may serve to give direction to the purchase of food material, thereby assuring full nutrition with the saving of that vast waste which is almost a disgrace to this nation?

The chemical standards of nutrition which have been established by Professor Voit and others in Germany, by Sir Lyon Playfair, by Dr. Pavey and other competent authorities in England, vary in some measure from the American standard. What I name the American standard is that which has been elaborated mainly through the investigations of Prof. William O. Atwater, Mrs. Ellen H. Richards and others. It contains a somewhat larger proportion of fat than the European dietaries; perhaps thereby becoming more suitable to the colder and more changeable conditions of the climate of the northern section of the United States.

Professor Atwater has converted the chemical units of nutrition in all the various dietaries of Europe and of the United States into units of heat or Calories. At this standard they are all substantially alike, even though they vary in some measure in their chemical elements. It is possible that the professor has builded better than he knew.

We may adopt the Calorie as the unit of nutrition. It may then become a very simple matter to prepare rules and tables that shall be a true guide to intelligent persons in the pur-

chase and in the consumption of food; not day by day, but by the adoption of standards corresponding in every way to the chemical elements and to the units of heat, say for thirty days. I think we may even put the whole art of nutrition by and by into the common school arithmetics, in the form of examples of addition, multiplication and the like; it seems to me that they would be very much better lessons for children than many of the logical puzzles in figures which I have found in the school arithmetics, that are wholly unfit to be there, perplexing children instead of teaching them.

I have made some progress in this matter, and I will now submit some of the results in the form of tables. They have not yet been revised by competent authorities to the full extent, but are in a broad and general way consistent with the true standards of nutrition.

The exact standard of nutrition for a man at active but not excessive work is seven hundred grams of actual nutritive material free of water, four hundred and fifty grams of carbohydrates or starch, one hundred and fifty grams of fats, one hundred and fifty grams of proteine, with such mineral ingredients as will be found in any miscellaneous dietary in sufficient measure. These elements will yield three thousand, five hundred and twenty Calories or mechanical units of heat; the Calorie being the amount of heat necessary to raise one kilo, or one thousand grams, of water, one degree centigrade.

In order to make allowance for unavoidable waste we may safely adopt four thousand Calories as the average unit of nutrition for a man at active but not excessive work for one day.

On this unit we may make variations by percentage in ratio to the kind of work done, the sex and the weight of the consumer.

In about the ordinary proportions of gram, meat and vegetables in which food is purchased, I find that one pound containing the proportions of starch, fat and nitrogen required by the American standard yields one thousand two hundred Calories.

A day's ration of four thousand Calories, therefore, calls for three and one-third pounds of food material of the ordinary kinds, tea, coffee and the sugar and cream used therein, water or other liquids consumed as beverages not being included in this computation. Beverages possess but little food value.

Now while it might be unreasonable to expect an exact measure or unit of nutrition to be adopted and put in practice day by day, it becomes a very simple matter to establish a rule for the purchase of one hundred pounds of food per month, or thirty days' rations at three and one-third pounds each.

As a tentative measure yet to be more accurately computed, I have made the following table consistently with those general rules.

It is not a fancy table. In order to get a true basis for the retail prices of the cheaper kinds of food in Boston, some of which, notably the prices of potatoes and of coarse hominy or samp, are very high, I employed a lady who is much interested in this matter to get prices in Boston at the South End, the superintendent of a branch of the New England Kitchen at the North End, the colored cook who is employed in my office kitchen at the West End, and my office boy, a bright lad, to get prices in the neighborhood of our largest market, Quincy Market. I averaged these four returns in making this table, and I have printed them all in one of my circulars.

My first table is made on the basis of the cheaper kinds of meat and fish and the best kinds of flour, grain and vegetables, all bought at retail. There is a considerable margin for reduction if these articles are bought in large quantities. If bread is bought rather than baked at home on my methods, the price of bread taken at two and a half cents a pound must be doubled in Boston. In New York you have better bread at three cents a pound cash at Mr. Samuel H-
National Bakeries than we can get in Boston at six

In reducing the pounds of food to nutrients an-

have assumed that the meat and vegetables will be purchased in variety, and I have therefore taken the average of each class of foods in my computation.

Thirty days' rations, yielding substantially twelve hundred Calories per pound in the proportion of three elements of starch to one of proteine and one of fat. Milk may be substituted for some of the meat fat or pork, but of course in much larger measure by weight.

TABLE 1.

Ration at Low Prices for the Cheaper Cuts or Portions of Meat and Fish; 1,200 Calories to 1 pound. Nutrients: Starch 3, Protiene 1, Fat 1.

	Price.	Amount.	Calories per Pound.	Total.
18 pounds neck and shin beef, mutton, flank, scrag, etc., ...	$0 06	$1 08	1,137	20,465
2 pounds suet or beef fat, . . .	05	10	4,000	8,000
2 pounds salt pork, ...	10	20	3,280	6,560
3 pounds butter, ...	30	90	3,615	10,845
6 pounds fish, ...	06	36	440	2,640
26 pounds bread, ...	02½	65	1,280	33,280
12 pounds oat meal and hominy, . .	04	40	1,700	17,000
4 pounds beans or split peas, . .	07	28	1,585	6,340
22 pounds vegetables or roots, . .	03	72	280	6,160
5 pounds sugar, ...	06	30	1,800	9,000
100 pounds, 1,200 Calories per pound, .	$0 05	$5 00	–	120,290

The exact standards of American nutrition are much higher than those of Europe, as they may well be in order that the much higher rates of wages which our people earn may be fully justified and sustained by the greater amount of potential energy which our abundant product of food enables us to supply at low cost. They are as follows: —

	Exact Calories.	With Waste Added.
1. Man at hard work, ...	4,060	4,600
2. Man at moderate work, ...	3,520	4,000
3. Man at light exercise or woman at moderate work, ...	2,815	3,200
4. Woman at light exercise, ...	2,300	2,600

On this basis, on the cost of the foregoing standard, —

Class 1 would require daily: $3\frac{7}{8}$, say 4 pounds food, 1,200 Calories per pound, at 5 cents per pound, ... $20
Class 2. $3\frac{3}{8}$, say $3\frac{1}{2}$ pounds, 1,200 Calories per pound, . . $17\frac{1}{2}$
Class 3. $2\frac{5}{8}$, say $2\frac{3}{4}$ pounds, 1,200 Calories per pound, . . $13\frac{3}{4}$
Class 4. $2\frac{1}{8}$, say $2\frac{1}{4}$ pounds, 1,200 Calories per pound, . . $12\frac{1}{2}$

On a minimum basis, therefore, yet one which may be readily adopted, the nutritive material which is necessary for a man at hard work in Boston can be purchased in small quantities at retail prices at twenty cents a day, or one dollar and forty cents per week; for a man at moderate work at seventeen and one-half cents a day, or one dollar and twenty-two and one-half cents per week; for a man at light exercise or a woman at moderate work at thirteen and three-fourths cents a day, or ninety-six and one-fourth cents per week; for a woman at light exercise at twelve and one-half cents a day, or eighty-seven and one-half cents per week.

As these purchases would be made in pounds, and as in every element a suitable addition has been made for what may be called reasonable waste, the common measure would be substantially as follows: —

Per Day.

Meats, ...	10 ounces.
Suet or fat, ...	1 ounce.
Salt pork, ...	1 ounce.
Butter, ...	$1\frac{1}{2}$ ounces.

Fish,	3	ounces.
Bread,	14	ounces.
Hominy, oat and corn meal,	6	ounces.
Beans or peas,	2	ounces.
Sugar,	3	ounces.
Roots and other vegetables,	12½	ounces.
Total,	54	ounces.

That does not sound like a very meagre diet.

I am not yet prepared to say how much this ration would weigh with the water added in the processes of cooking.

The bread is computed with the water in it, which the flour takes up at forty per cent. on the weight of flour.

Meats and fish may be combined with water in different portions; as the coarse or tough parts are better in soups, stews and hashes, the water added would be in large proportion.

Hominy and meal take up several times their weight in water, while vegetables shrink both in the preparation and in cooking. I should think this unit of nutrition at three and one-third pounds would weigh about five pounds after cooking. I am too much of a sedentary man, and I find that my average ration of cooked food aside from beverages is about three and one-half pounds, and on the basis of the dietary submitted I could live well at one dollar per week.

In anticipation of this meeting I devoted Fast Day, April 2, to some experiments. I caused one of my ovens to be substantially filled with food, in eight combinations.* This experiment is repeated in one of these ovens to-night, which we will presently open.

The food purchased was as follows: —

2 pounds shin beef, without bone, 7 cents,	$0 14
2 pounds veal, without bone, 5 cents,	10
2 pounds beef liver,	16
½ pound bacon,	07

* The latter part of this treatise is taken from a lecture given in Columbia College, New York, at the instance of Prof. Thomas Egleston.

2 pounds mutton flank, ...	$0 10	
1 pound suet, ...	05	
2 pounds halibut nape, ...	10	
½ pound salt pork, ...	06	
12 pounds, meat, fat and fish, ...	——	$0 78
Grain.		
1 pound hominy, ...	$0 04	
¾ pound oat meal, ...	03	
1 pound corn meal, ...	03	
¼ pound rice, ...	02	
3 pounds, ...	——	12
Vegetables.		
4 pounds potatoes, ...	$0 10	
1 pound turnips, onions, etc., ...	05	
5 pounds, ...	——	15
4 pounds, 2 quarts skim-milk, ...		16
Salt, spice, etc., say, ...		04
		$1 25

Twenty pounds solid, four pounds liquid, twelve pounds water, equals thirty-six pounds, put into the oven at half-past nine A.M.; removed from oven at two P.M. Weight of cooked food thirty-two pounds; loss by evaporation of water four pounds.

I have not computed the Calories or nutrients in this quantity. It is intended to show what can be done in one oven at one time. It took somewhat less than one hour to prepare the eight combinations, namely, one dish each. They are as follows: beef and hominy hash; veal, hominy and tomato; mutton stew; liver and bacon with corn meal; halibut nape and potato, baked; oatmeal, plain; poor man's pudding; baked Indian pudding.

You may presently test the quality of these combinations. We have put in forty pounds this time and may take out thirty-five to thirty-six.

With such a lot of food, strong in fat and nitrogen, there should be at least twelve pounds of bread and twelve pounds of vegetables, say twenty-four pounds at two and one-half cents, sixty cents; thirty-six pounds cooked as recited, one

dollar and twenty-five cents; add for dried apple sauce or some cheap kind of fruit, fifteen cents; total, sixty pounds at a cost of two dollars.

You don't half believe it. Nor did I until I had proved it more than once. Presently you shall have an object lesson.

Now, if my method of combining nutrition and arithmetic by the standard of Calories and nutrients combined has no other result, it may lead to as much attention being given to the nutrition of the human beings in city institutions as is given to feeding the horses in the city stables. From some communications that have been made to me I am inclined to think that right at this point is a place for scientific charity.

I gave a seven-course dinner party at my house a few days since to my whist club and friends, including oranges and coffee, which cost thirteen cents each for food material. Each cigar consumed after dinner cost more than the dinner.

I lately gave a dinner of four courses, soup, fish, meat and vegetables, and mush with molasses for dessert, to nine of the poorer students at Harvard who want to economize; there were three others; each had a pound and a half of strong food. The cost for the twelve was sixty-one cents.

The quantity of oil of one hundred and fifty degrees flash test that will be consumed on this forty pounds is one and one-half pints, at one and one-half cents per pint; two and one-fourth cents.

There may be some variations to be made on the American standard.

In the judgment of Sir Henry Thompson, with whom I consulted personally, we concentrate our food a great deal too much in this country; we fine down our flour and lose in nutrition as well as in bulk; we also eat too much meat and fat. Moreover, the ration of meat and fat which may serve us well in winter may serve us ill in summer.

In order to meet these variations we may change the thirty-day dietary. When we substitute more grain and

vegetable food we reduce the Calories per pound and we therefore require more pounds a day.

We may also change the nutrients from starch 3, proteine 1, and fat 1, to starch 4, proteine 1.1, and fat 1.

On this basis I submit Table 2, one thousand Calories to a pound, in the ratio of starch 4, proteine 1.1, fat 1.

TABLE 2.

QUANTITY.	Calories.	Nutrients per Pound.	Cost.
18 pounds of meat, . . .	1,137	20,465 at $0 06	$1 08
6 " " fish, . . .	440	2,640 " 06	36
3 " " butter, . . .	3,615	10,845 " 26	78
25 " " bread, . . .	1,280	32,000 " 02½	63
12 " " grain, . . .	1,700	20,400 " 04	48
33 " " vegetables, . .	250	8,250 " 03	99
3 " " sugar, . . .	1,800	5,400 " 06	18
100 pounds, . . .		100,000	$4 50

QUANTITY.	Cents.	Cost.	One Ration.	
			Ounces.	Pounds.
72 pounds meat, ...	6	$4 32	12	¾
24 " fish, ...	6	1 44	4	¼
12 " butter, ...	26	3 12	2	⅛
100 " bread, ...	2²	2 52	16	1
48 " grain, ...	4	1 92	8	½
132 " vegetables, . . .	3	3 96	20	1¼
12 " sugar, ...	6	72	2	⅛
400 pounds, ...	4½	$18 00	64	4

This table is also of a somewhat rough-and-ready sort, and must be carefully revised before it can be established. You will observe that it requires four pounds of this combination at one thousand Calories per pound to give the unit of nutrition at four thousand per day, but as the price per pound is less, the variation in the cost of a day's ration comes to very little.

In this ration again milk may be substituted for some of the meat and fat.

It will be observed that in these low-priced dietaries I have not included eggs. In our factory boarding-houses in Massachusetts the consumption of eggs per adult is one every other day. One egg every other day at sixteen and one-half cents a dozen comes to three dollars a year per adult; fifty million adults, one hundred and fifty million dollars ($150,000,000) a year for eggs! the measure of the hen industry.

If eggs are added at four per week, at three cents each (city prices for fresh eggs), twelve cents; with fruit at eight cents per week; tea and coffee, seven cents; total for extras twenty-seven cents, the unit of nutrition at the low-priced standard would be as follows: —

Per Day.

Class 1.	Food, $0 20	+ eggs, fruit and beverage,	$0 04, .	. $0 24
Class 2.	Food, 17½	+ eggs, fruit and beverage,	04, .	. 21½
Class 3.	Food, 13¾	+ eggs, fruit and beverage,	04, .	. 17¾
Class 4.	Food, 12½	+ eggs, fruit and beverage,	04, .	. 16½

Per Week.

Class 1, ...	. $1 88
Class 2, ...	. 1 50½
Class 3, ...	. 1 24½
Class 4, ...	. 1 15½

This is a sketch of the elements of the science or art of nutrition, which may perhaps be perfected and may possibly be taught in the common school arithmetics.

I have thus presented a theory of nutrition at a minimum cost. But it could only be attained in practice by people of

more than common intelligence under our existing conditions; it would be almost impossible to attain with the use of the cooking apparatus now in common use; yet at this standard, witness to what incomprehensible figures we are led when dealing with the whole mass of our population.

Whoever is right as to the enumeration of the census year, we now number sixty-five millions. If we make the utmost reduction for children of ten or under, keeping in consideration the larger need of growing children from ten to seventeen, also bearing in mind the great proportion of all who get their living by "the sweat of their brow," and who must have ample nutrition, we cannot estimate the present consumption of food at less than what would be required by fifty million adult men at active or moderate work or women at active work. We may compute our total consumption on a basis corresponding in requirements to a standard of nutrition somewhat under class two and a little over class three, costing fourteen and one-fourth cents a day, or one dollar a week for food; to which we may add a quarter of a dollar a week for eggs, tea, coffee and fruit.

At $52 per year the food necessary to sustain 50,000,000 adults comes to $2,600,000,000; at $13 per year, the eggs, tea, coffee and fruit come to $650,000,000; total for food and wholesome drink, $3,250,000,000; the most conservative estimate of the cost of beer, wine and spirits to the consumers is $750,000,000; total, $4,000,000,000.

The problem with which we are dealing is the mere alphabet. We are at the beginning of an attempt to apply the same science to the nutrition of man that we have so long been attempting to apply to the nutrition of the soil, the plant and the beast of the field; our problem is how to cook not less than *three billion dollars' worth of meat, fish, grain and vegetables a year.*

I think you will admit, gentlemen, that it is quite time to apply science in the kitchen, and to develop a true and simple art of cooking.

At what price will you measure the waste of labor, the

waste of fuel, the waste of heat, the waste of comfort, the waste of temper, the waste of health, the waste of morality and sobriety due to the waste upon whiskey, which is again due to lack of well-cooked food? Is this waste a billion dollars' worth of potential energy a year? Is it not a great deal more?

Perhaps you will come to the conclusion that the potato gospel will bear a great deal of preaching.

Ought there not to be a cooking laboratory attached to every agricultural experiment station? Would one be out of place even in Columbia College?

But, gentlemen, there is another aspect of this case. True economy does not consist in living on shin of beef or halibut nape. Very few people can afford to use up the time that would be required to live at a cost of a dollar a week, or at fourteen cents a day, unless obliged to do so. There is a certain horse sense in the reply of the workman to some of these suggestions when he says "We don't want your bone soup," and "We won't have your pig-wash." Give us something better, or what we are used to, better cooked than we now get it.

Suppose we double the price, put up the prices of the animal food to rates which would be paid for good solid meat, free of bone, of good quality; add a pint of milk, an excess of butter and one egg every day. I think this ration corresponds closely to the average consumption and expenditure in the families of well-to-do people, if we add to this food ten cents a day for tea, coffee, condiments and fruit, making the total fifty cents for each inmate of the household per day.

TABLE 3.

Four Pounds Food at 1,200 Calories per pound equals 4,800 Calories; One Pound Milk added, 310 Calories, makes 5 pounds, 5,110 Calories.

½ pound clear meat at an average of 20 cents per pound, . .	$0 10
¼ pound fish at 16 cents per pound, ...	04
¼ pound butter at 36 cents per pound, ...	09

TABLE 3 — Concluded.

1 egg at 36 cents per dozen,	$0 03
1 pound, 1 pint milk,	04
1 pound bread,	02[e]
¼ pound oat meal, rice, hominy or corn meal,	01½
1¼ pounds vegetables,	03[e]
½ pound sugar,	03
5 pounds,	$0 40

This would be an excessive allowance for a man at very hard work; if it were all cooked in such a way that it could be assimilated, with water added, it would weigh as much as seven pounds. Few persons really consume more than half such a daily ration.

You will find that fifty cents' worth a day per inmate comes into your houses, even if you think you live rather simply. It cannot be consumed. How much is wasted?

I myself eat about three and a half pounds a day, including soup, but not including fruit or beverages. At my standard about three-fifths of that ration, or twenty-four cents' worth, suffices.

If proper methods of cooking were adopted and right methods of utilizing what is now wasted in the ordinary method of buying and preparing this food material, all the potential energy in this dietary could be enjoyed by the average adult at twenty-eight cents a day, or in round figures at two dollars per week.

At two dollars a week the food bill of fifty million adults comes to five billion, two hundred million dollars a year ($5,200,000,000).

By statistical analysis of our crops and food products, projected from the gross valuations and wholesale data to their points of ultimate consumption, I am fully satisfied that the food bill of this country is in fact as much as five billions of dollars, and is probably more ($5,000,000,000).

I am also satisfied that one-fifth part of this huge volume of good material is converted *into bad feeding* for lack of

science in the economy of the kitchen, one billion dollars' worth a year of wasted potential energy ($1,000,000,000).

Life is but a conversion of force which takes the form of clothing, food and shelter; that is all that any of us get out of the material products by which we are sustained, sheltered and clothed.

If this misdirection of force of one billion dollars, which is represented by these huge figures, were converted by the saving of that part of the potential energy in the food consumed which is now wasted, or if that energy now wasted were given a new direction into the work that would be required to provide house room, nearly twice the shelter now enjoyed would ensue. The worst problem with which we are called to deal would then be solved.

The family now in one room could have two. The destruction of the poor is their poverty and the worst waste of food is among them. The family now in three rooms might have five, and those who now have as many rooms as are required could direct the force now wasted to greater comfort and to the higher plane which only in the long run makes life worth living.

Have my figures led you away into visionary conceptions, such as any one may find in the dry columns of statistical science, if only he has the eye to see what is written between the lines or is inscribed behind the columns?

APPENDIX.

Retail prices of the tougher portions of meat and of the best kinds of grain and vegetables in Boston in the spring of 1891. Vegetables rated at a higher price than usual on account of a great scarcity of potatoes.

	Per lb.		Per lb.
Beef — average of neck, shin, flank, and some of the better portions, omitting expensive cuts,	6 cents.	Salt cod,	8 cents.
Beef suet, selected,	5 to 6 "	Halibut nape,	5 "
Beef, corned,	6 "	Whole milk,	8 "
Beef liver,	6 "	Skimmed milk,	4 "
The cheaper parts of mutton,	6 "	A good quality of cheese,	16 "
Corned pork,	8 "	A fair quality of butter,	28 to 32 "
Salt pork, varying in different years, now,	8 "	Corn meal,	2½ to 3 "
Smoked ham,	12 "	Oatmeal,	4 to 5 "
Bacon,	12 "	Cracked wheat,	5 "
Sausage of good quality,	16 "	Split peas and dried whole peas,	7 to 9 "
Veal, the cheaper parts,	8 "	White beans,	7 to 8 "
The cheaper kinds of fresh fish,	6 to 8 "	Rice,	6 to 10 "
		Hominy,	4 "
		Potatoes, very scarce,	2½ "
		Turnips,	2½ "
		Onions, scarce,	5 "
		Beets,	5 "
		Carrots,	2½ to 3 "
		Squash,	3 "
		Cabbage,	2½ "

[No. 51.]

N. E. COTTON MANUFACTURERS' ASSOCIATION.

PROCEEDINGS

OF THE

SEMI-ANNUAL MEETING,

HELD AT BOSTON,

OCTOBER 28, 1891.

BOSTON:
WRIGHT & POTTER PRINTING CO.,
19 POST OFFICE SQUARE.
1891.

cotton manf.

[No. 51.]

N. E. COTTON MANUFACTURERS' ASSOCIATION.

PROCEEDINGS

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OF THE

SEMI-ANNUAL MEETING, 1896.

HELD AT BOSTON,

OCTOBER 28, 1891.

BOSTON:
WRIGHT & POTTER PRINTING CO.,
18 POST OFFICE SQUARE.
1891.

CALL FOR MEETING.

BOSTON, Oct. 6, 1891.

DEAR SIR: — The stated semi-annual meeting of the Association will be held at the Massachusetts Institute of Technology, Boylston Street, Boston, on Wednesday, Oct. 28, 1891, at 10 o'clock A.M.

Topics heretofore discussed will still be in order if called up by any member; and, in addition, the Board have the pleasure to announce the following: —

Col. JAMES FRANCIS of Lowell, Mass., will present a paper on METHODS OF PRESERVING TIMBER IN SITUATIONS WHICH EXPOSE IT TO DECAY.

Mr. SAMUEL D. CRAFTS of Boston, Mass., will read a paper on WOOD VULCANIZING.

Mr. FRANCIS P. SHELDON of Providence, R. I., will present a paper upon POWER AND SPEED IN COTTON MILLS.

Copies of these papers will be printed in advance of the meeting, and will be supplied to any member who shall apply for them to the secretary.

By order of the Board of Government,

AMBROSE EASTMAN,
Secretary.

PROCEEDINGS.

Pursuant to the foregoing notice, the stated semi-annual meeting of the Association was held at the Massachusetts Institute of Technology, Boylston Street, Boston, on Wednesday, Oct. 28, 1891, at 10 o'clock A M.

The President, Mr. WALTER E. PARKER, occupied the chair.

The President submitted the following nominations of new members, recommended by the Board of Government, for election: —

Messrs.	JOSEPH D. AIKEN,	Williamsville, Conn.
	JAMES A. ATWOOD,	Wauregan, Conn.
	LEWIS C. BASS,	Boston, Mass.
	FRANK B. COMINS,	Providence, R. I.
	FRANK R. HADLEY,	New Bedford, Mass.
	DAVID S. JOHNSTON,	Cohoes, N. Y.
	GEORGE F. MORGAN,	Lowell, Mass.
	ALBERT H. MORTON,	Lowell, Mass.

The foregoing names were then voted upon separately, and each nominee was duly elected to membership in the Association.

The President then introduced Col. James Francis of Lowell, Mass., who read the following paper: —

METHODS OF PRESERVING TIMBER IN SITUATIONS WHICH EXPOSE IT TO DECAY.

By James Francis, Lowell, Mass.

The perishable nature of wood, especially when placed in situations where there is an excess of moisture in the surroundings, has led to many experiments with a view to discover a process of treating timber with salts or oils, that would preserve it from decay.

Dry rot, sometimes called sap rot, the most formidable disease to which timber is subject, is commonly attributed to a combination of the acids found in the sap with the oxygen of the air, which produces fermentation followed by decomposition. Unseasoned timber, placed in damp situations with but partial ventilation, will soon show signs of dry rot. Beams which presented the appearance of being sound on the outside have been found completely rotten inside. The shell remains sound because it becomes seasoned, and relieved from the sap.

Wet rot, as distinguished from dry rot, is considered to be occasioned by alternate exposure to moisture and dryness, beginning at the surface of the timber and working inwards. Piles and other timber placed in salt or fresh water will show signs of wet rot at the water line, before it attacks other parts. Posts, set in the ground, first begin to rot at the ground line.

Among the earlier investigators on the subject of preserving timber may be mentioned Johann Glauber, the famous chemist of Carlstadt, Germany, who in 1657 experimented with vegetable tar and pyroligneous acid; the wood having been first carbonized by the action of fire, then covered with a coating of

tar and immersed in pyroligneous acid. Since then up to 1846 no less than forty-seven different processes, adapted for the preservation of wood, are recorded, besides others of more recent date. Of these processes many of them would, no doubt, prove effective, provided they could be carefully and economically applied. It is a difficult problem to treat timber in large quantities and meet with reasonable success.

The condition of the timber that is to be treated should always be considered. It should be sound. The trees should be cut during the season when the least amount of sap is flowing, which in this section of the country is in winter, say from November to February. It should not be treated in a frozen state, and it is advisable to shape the timber to the form in which it is to remain, before the treatment is applied. Seasoning is a very important factor. A few months of exposure to the air and sun will materially add to the durability of the wood. The process of treatment must be rigidly and faithfully performed. The opportunities for gross frauds which cannot readily be detected are many, and the numerous instances of record where cheating has been systematically carried on at works established for the purpose of treating timber, prove that the safest course for parties using preserved timber is to do the work themselves.

Three of the well-known processes for preserving timber are the following, viz.: —

Creosoting, creosote oil, so called, being the antiseptic.

Burnettizing, chloride of zinc being the antiseptic.

Kyanizing, corrosive sublimate being the antiseptic.

Creosoting.

The creosoting process consists in injecting timber with hot creosote oil, in a closed cylinder, under pressure. It was invented in 1838 by John Bethel of England, who found that, by forcing at least seven pounds of creosote oil into each cubic

foot of timber, the process was satisfactory for railroad ties and other railway work, but that for marine work it was better to have not less than ten pounds per cubic foot. In this country experimenters have used from ten to twenty pounds of creosote oil per cubic foot, and the estimated cost is from twelve to twenty-four cents per cubic foot, or ten to twenty dollars per thousand feet board measure. Creosote oil, such as is most commonly used in this country and abroad for the treatment of wood, is distilled from coal tar. It is a heavy oil which will sink in water, and contains carbolic acid, creosote and other constituents, considered essential for the preservation of wood.

Wood creosote oil is distilled from wood tar. It is a lighter oil than that distilled from coal tar, and its cost is less. It is but slightly soluble in water, and is not a specific poison. An oil distilled from the heavily resined pine wood found in the Carolinas has been used since 1885, for the treatment of piles and timber, by the Carolina Oil and Creosote Company of Wilmington, North Carolina, who claim that the wood creosote oil possesses much better antiseptic qualities for preserving wood than exist in the heavier oil obtained from coal tar. This Carolina oil weighs about eight and one-half pounds per gallon.

Creosoting, for many situations and conditions, is considered the most perfect process in use, and it is the only effectual agent known that will preserve wood against the attack of the marine worms, *Teredo* and *Limnoria*, which are found along the Atlantic coast, and are confined strictly to salt water.

Naturalists have carefully studied the mechanism and habits of the *Teredo*. They find that the worm, when young, penetrates the wood by a very small opening, under the surface of the water and usually near the surface of the ground, then changes its course in order to follow the direction of the fibre. It feeds and grows in the wood, and the length of its hole, which in some cases reaches sixteen to eighteen inches and even longer, represents about the length of the worm.

It never enters the wood beyond its length, being dependent upon having its tail end in the clear salt water, outside of the wood, through which it is believed the *Teredo* receives its nourishment from the animalculæ in the sea water. Myriads of these worms, varying from one-twenty-fifth of an inch to one-fifth of an inch in diameter, at work in the heart of a driven pile, quickly perforate and destroy it. The Royal Academy of Science in Holland reported upon the means of preserving wood from the *Teredo* in 1866, as follows: —

"The only means which can be confidently regarded as a preservative against the ravages of the *Teredo* is the creosote oil; nevertheless, in the employment of this agent great care should be taken regarding the quality of the oil, the degree of penetration and the quality of the wood treated."

The creosoting works of the Old Colony Railroad Company, situated at Somerset, Mass., are employed mainly for treating the oak piles of the company, used in and about Fall River, to guard against decay and the ravages of the *Teredo* that swarm in that section of Taunton River. These works have been conducted for many years with reasonable success, and to such an extent as to repay them for the outlay and the trouble.

The *Limnoria*, another very destructive worm or grub, is found along the shores of New England. It is less than a quarter of an inch in length, and burrows into the wood to a depth of about one-half an inch; and when numerous it will quickly reduce the wood to a series of thin partitions between the burrows, which after a while become broken and washed away by the action of waves. The new surface is at once attacked, and the work of destruction goes on until the wood is entirely eaten away. Sometimes the *Limnoria* and the *Teredo* are found in the same structure, — both working under water, the former eating from the outside, while the *Teredos* penetrate and honeycomb the interior.

Creosoting is far from being a cheap process, and for this reason perhaps more than any other it has failed to be exten-

sively adopted in New England. Creosoting meets with favor in England, and at the present time it is the only process that is carried on there with any degree of magnitude and success.

Burnettizing.

Burnettizing was introduced by Sir William Burnett of England in 1838. The invention consists in destroying the tendency of certain vegetable and animal substances to decay, by submitting them to the action of chloride of zinc. The degree of dilution recommended by Burnett is one part by volume to fifty parts of water. The method of impregnating the wood under a pressure of seven to eight atmospheres, as is done in the creosoting process, is most commonly used. The cost of burnettizing is about one-half as much as creosoting, or, say, from five to six dollars per thousand feet board measure.

There are no burnettizing works of any extent in New England, at the present time. Some of the railroads in various parts of the country have experienced good results from the burnettizing of ties, especially ties of soft wood, such as pine, tamarack, hemlock and cedar. Among them may be mentioned the Rock Island & Pacific Railroad, the Lehigh & Susquehanna Railroad and the Vermont Central Railroad.

The process was introduced at Lowell in 1850, and conducted faithfully for about twelve years, during which period a very large amount of timber was burnettized for bridges and for other structure purposes in exposed situations. But the results were not always satisfactory to Mr. Francis, under whose supervision the works were built and conducted, and in 1862 the process was abandoned.

In Germany burnettizing meets with more favor. The Stuttgart Technical Convention of 1887 expressed itself as follows: —

"As the experience of those railroads that have from twenty-five to twenty-six years impregnated their ties with chloride of zinc, under pressure, after steaming and abstracting the sap,

has been very satisfactory, and as this system costs only one-half to one-third as much as impregnation with creosote or corrosive sublimate, the majority of railroads have adopted the chloride of zinc process."

Steaming the wood under a pressure of sixty to seventy pounds per square inch, as done in Germany, preparatory to burnettizing, no doubt adds to its durability. Tredgold considers that steamed timber shrinks less and stands better than that which is naturally seasoned. Barlow, another good authority, is of opinion that the seasoning goes on more rapidly after the piece is steamed. If steaming had been done in Lowell, in connection with burnettizing, it is very probable that the results would have been more satisfactory.

Kyanizing.

This process was invented and introduced in England, in 1832, by John Howard Kyan. It consists in steeping the wood in a solution of corrosive sublimate, and the degree of dilution is usually one pound of the salts to ninety-nine pounds of water. It is a very slow process, compared with those in which the wood is impregnated under a pressure, and requires about as many days for treatment as creosoting or burnettizing would require hours. The usual rule in this vicinity is to allow the timber to steep in vats for a length of time depending upon its least thickness: thus, if the timber is ten by twelve inches thick, it would remain in the vats eleven days; if six by nine inches, it would steep seven days. In Baden, timber ten by twelve inches would remain in vats eighteen days, and if six by nine inches, ten days. Bichloride of mercury, which is the antiseptic in this process, contains muriatic acid, which acts upon iron; and it is found impracticable to attempt to impregnate the wood under a pressure in iron cylinders, as can be done when creosote oil or chloride of zinc is used.

Kyanizing was introduced at Woolwich, England, by the

Royal Engineers, in 1836. Captain Alderson of the Royal Engineers about that time reports a case as follows: —

"I was informed of the return of the ship 'Samuel Enderby' (four hundred and twenty tons, built at Cours in 1834), as having been built entirely of saturated timber (kyanizing process), the same process having been also applied to the sails and rigging. It was said she had returned in a state of decay, and that the experiment was a complete failure. I lost no time in going on board and inspecting her, as well as in making inquiries as to the health of the crew. The mate informed me they had all been quite healthy, that no death had occurred during the twenty-nine months they had been absent, and that since May last they had not had even a medical man on board. I next examined the bilge water; it was without any unpleasant taste or smell, excepting what arose from the oil that floated on the surface, the ship having a full cargo of sperm oil. On examining various parts of the timbers of the vessel, from the upper deck to the keelson, they were perfectly sound. The mate said he considered the vessel as sound as the day she was launched, and a very tight ship. With respect to the sails and rigging, however, he said they had not answered as well as was expected; and on enquiring at Mr. Enderby's manufactory, where they were made, I found it was not the first time this had occurred, where the canvas had been constantly exposed to the light, though it had invariably succeeded under the most unfavorable circumstances and situations, where light was e[illegible]d or only partially admitted."

Mr. James B. Francis, who has given a great deal [illegible] study to this subject, was sent to England in 1849 by [illegible] manufacturing companies of Lowell, to ob[illegible] the [illegible] in use there for preserving timber from [illegible] 17, 1849, he examined the same ship, [illegible] then in port at the West India Docks, [illegible] was empty and had been in port about [illegible] found very few signs of decay, and was [illegible]

wright who was with him that he considered her in much better order than is usual in ships of her age. The ship was then fifteen years old.

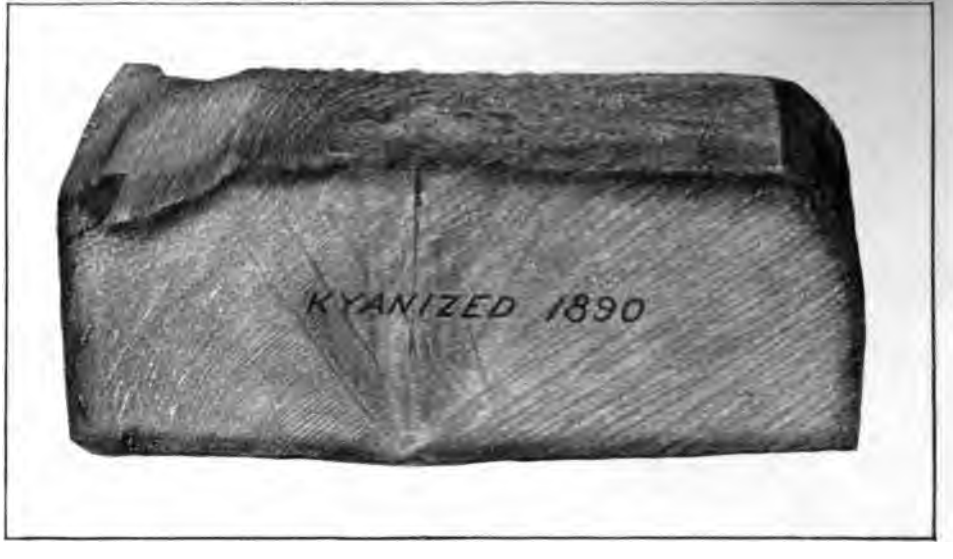
Professor Faraday, lecturer at the Royal Institution, London, explained in one of his lectures in 1833 that the preservation of the wood arises from a chemical combination which takes place between the corrosive sublimate and those albuminous particles which Berzelius and others of the highest authority consider to exist in, and form the essence of, wood; which, being the first parts to run to decay, cause others to decay with them; also, after witnessing various trials, extending to five years, in the fungus pit at Woolwich, in all of which the prepared timber and canvas came out perfectly sound, whilst the unprepared were decayed, he gives his opinion that the process would be found effectual in preserving timber, and that the improvement would be so great as fully to justify its extensive application.

Professor Faraday experimented upon the penetration of the solution into the wood by the application of hydrosulphuret of ammonia, which will turn black on meeting with mercury. In a cube of elm he traced the corrosive sublimate to the depth of from one-fifth to one-fourth of an inch; in a cube of oak, one-fourth of an inch; in a cube of fir, from one-eighth to one-sixth of an inch. In the latter, the resin in the wood had probably offered the obstruction to penetration.

Plate I. illustrates an experiment recently made in Lowell on the penetration of the mercury, in a section of two-inch spruce plank kyanized in 1890. The dark shaded part around the edge shows the penetration of the mercury as indicated by the application of a few drops of hydrosulphuret of ammonia. The penetration can be easily traced to a depth of about one-fourth of an inch.

In considering this process, Professor Faraday has always looked upon the excess of corrosive sublimate in the parts towards the exterior of the timber as a most important condi-

PLATE I.



Section of Spruce plank, kyanized in 1890, tested for mercury with hydro-sulphuret of Ammonia.

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tion; and a strong argument with him in favor of the process is the well-known fact that such matter will gradually penetrate the wood by those forces which tend to give a uniform distribution of fluid within the pores of any porous matter, and which will be influential, though the pores be not full of fluid, the wood being in what is usually called a damp state.

There is one other consideration which was of importance to Faraday in forming a judgment on this process; it is, that, where the exterior is preserved from change, the chances that the interior will decay are greatly diminished. For instance, piles or timbers charred on the outside preserve the interior parts from decay for a much longer period, so he thinks it safe to conclude that even an external preparation of timber would greatly diminish the probability of internal decay; and this, in combination with the gradual penetration of the substance to the centre, is the reason why he entertained little doubt of the value of the process of kyanizing.

But kyanizing has gone out of use in England. It was abandoned many years ago. Mr. James B. Francis, after a most careful investigation of the matter in 1849, attributes the cause to be entirely independent of the success of the process itself, when properly applied.

Among the causes that led to the abandonment of the kyanizing process in England may be mentioned:—

1. The mismanagement of the celebrated Anti Dry Rot Company, which was a disgrace, and which created a r[illegible]al prejudice against the whole subject of the preserva[illegible] ber by kyanizing.*

2. The Rothschilds had a monopoly of the Spanish quicksilver mines, and practically cont[illegible] ket, as they do to-day; which had, and now h[illegible] materially increasing the cost of corrosive subli[illegible]

* The Anti Dry Rot Company, London, purchased the patent [illegible] Kyan. Preparations were made for an extensive introduction of [illegible] country; but, after a brief period of considerable notoriety, the [illegible] upwards of £70,000, which ruined the company.

3. Sir William Burnett had been able to get his process of burnettizing introduced by the Admiralty.

Kyanizing was introduced at Lowell in 1848, by the Proprietors of the Locks and Canals on Merrimack River, a corporation which manages the water power at that point, and maintains a number of wooden bridges over the various canals and also other important structures of wood, which, if not preserved by artificial means, would rapidly decay. The subject of preservation of timber was an important one for them, and the kyanizing process was selected, and considered to be the best process then in use for their purposes. Two years afterwards, in 1850, the burnettizing process was substituted, and continued for twelve years until 1862, as previously mentioned; and it was believed for a time to be equally effective, cheaper and more expeditious than kyanizing. But in 1862 kyanizing was again resumed, as it was found to be a better preservative for their bridge timbers and other works, and the burnettizing process was abandoned. The experience at Lowell during this long period of forty-three years, since 1848, has clearly proved that, under proper conditions, kyanizing will materially prolong the life of wood, and the process appears to be well adapted for the preservation of wooden bridges, posts, fences, and all timber placed in exposed places; but it is well known that, as corrosive sublimate is easily soluble in water, timber treated with it and then placed in water will no doubt lose a portion of the sublimate by washing out.

Plate II. is a view of specimens of twelve kinds of wood placed as posts in the yard of the Proprietors of the Locks and Canals, at Lowell, in light, gravelly soil, well drained. In 1862 these specimens were selected from various kinds of wood that grow in New England. They were made eighteen feet long, nine by nine inches square, except No. 12, which was seven by seven inches square. The specimens were numbered, then cut in two, and one-half of each specimen was kyanized and the other half retained in its natural state. In the following

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PLATE II.

Posts planted to equal depths in the yard of Proprietors of Locks and Canals, Lowell, Mass. Those in front row were kyanized in 1862 and those in back row were left in the natural state. The boxing about the kyanized specimens protect them where pieces for exhibition have been taken out. All specimens in the back row are boxed to prevent them from falling to pieces.

Photographed in 1891.

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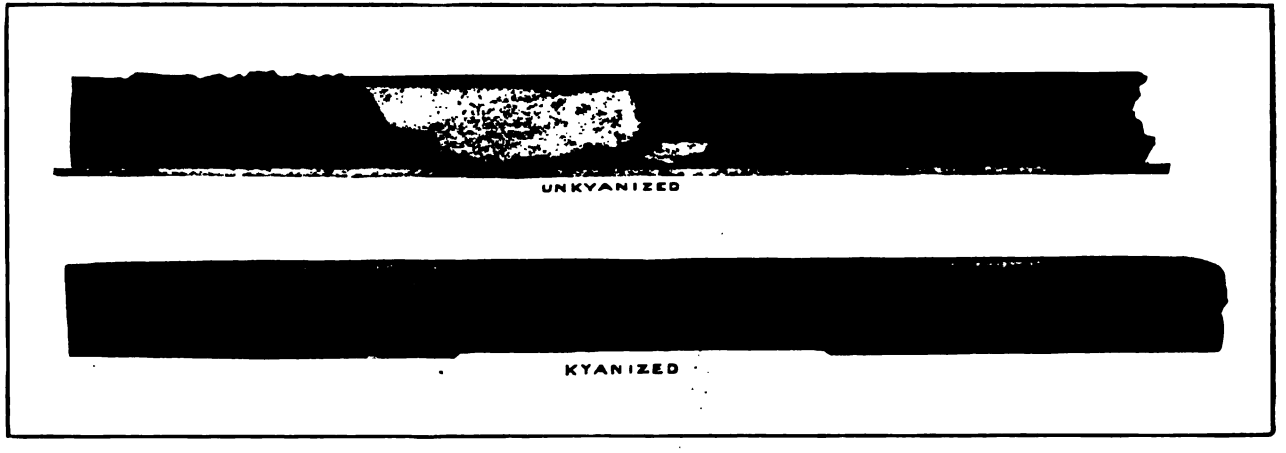
PLATE III.



Specimens of Old Growth White Pine, from a post 9″ x 9″, 18 feet long, cut in two. One half was kyanized in 1862 and the other half left in the natural state. Both parts were planted to an equal depth in the ground April 29, 1863. Dug up and photographed in 1891.

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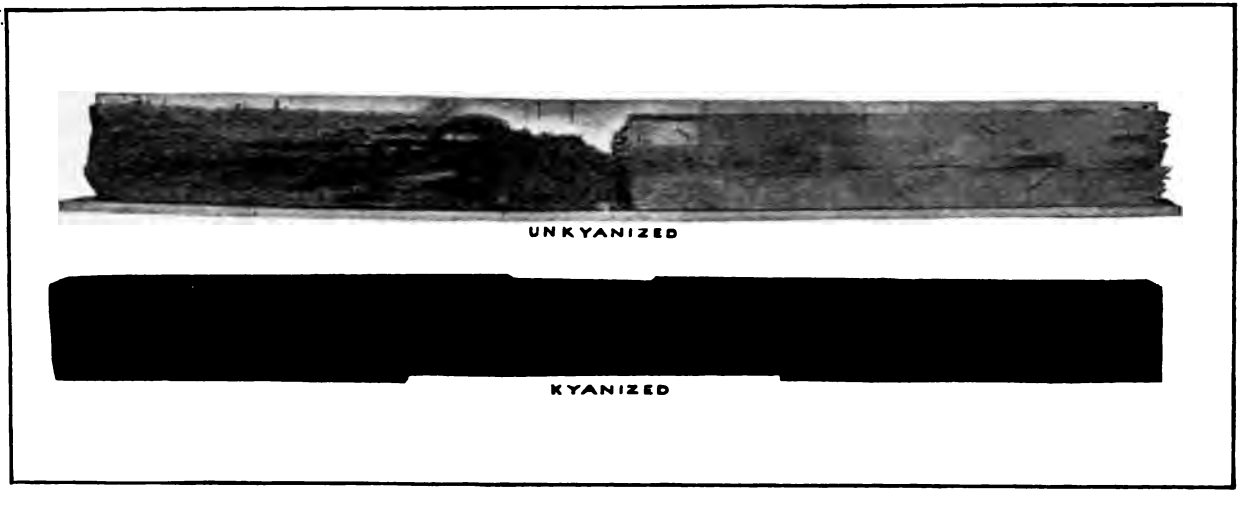
PLATE IV.



Specimens of Spruce, from a post 9″ x 9″, 18 feet long, cut in two. One half was kyanized in 1862 and the other half left in the natural state. Both parts were planted to an equal depth in the ground April 29, 1863.

Dug up and photographed in 1891.

spring, April 29, 1863, the specimens were planted in two rows, about four feet of their length in the ground. The posts in the front row are in a fair state of preservation, all, with the exception of No. 12, retaining their forms and strength to a degree that is favorable to the process of kyanizing, while some of them appear to be quite sound from top to bottom. The posts of the back row, which are not kyanized, are completely rotten, and, in order to keep the remnants, they have been boxed in.

The boxing of two sides of each kyanized specimen in the front row, shown in Plate II., is for the purpose of preventing the soil from coming in contact with the interior of the posts, where specimens were cut out in the spring of 1883; but there is no evidence of decay at those points at the present time.

The following is a schedule of the specimens: —

No. 1. Old-growth white pine.
No. 2. Sapling white pine.
No. 3. Northern white pine.
No. 4. Spruce.
No. 5. Hemlock.
No. 6. Beech.
No. 7. Black birch.
No. 8. Yellow birch.
No. 9. Rock maple.
No. 10. White maple.
No. 11. Brown ash.
No. 12. Poplar cottonwood.

The kyanized specimen of the Italian poplar, No. 12, which is now so much decayed near the surface as to lean over, was in a fair state of preservation up to 1885, a period of twenty-three years.

Plates III. and IV. are views of specimens No. 1 and 4 respectively, specified in the foregoing schedule as old-growth white pine and spruce, which have been recently dug up and photographed. It will be observed by a glance at the plate

that the kyanized specimens are virtually sound in every part, while the specimens left in the natural state have become rotten and entirely worthless. The specimens shown in these plates, both kyanized and unkyanized, have been exposed to decay, with about one-half of each post buried in the ground, for upwards of twenty-eight years.

Plate V. is a view of a portion of Pawtucket Street Bridge, over the Northern Canal at Lowell, built in 1849. The timber is northern white pine, and is all kyanized. No repairs were made upon it, except the surface planking, until April, 1882, when three of the stringers were found defective from dry rot, and they were replaced with new ones. Also, the lower ends of some of the braces showed signs of decay where they came in contact with the stone masonry, and the decayed parts were then cut off and replaced with new timber. Since 1882 no repairs have been made except to the railings. The bridge is now in good order, and will wear for some years yet before any extensive repairs will be needed.

Plate VI. is a view of a portion of the picket fence, eight feet high, which was built around a reservoir of water on Lyndes Hill, in Lowell, in 1850. The posts are about six by eight inches, and were planted to a depth of about three and one-half feet in light, gravelly soil. The spruce timber of which the posts are made was purchased two years previous, in 1848, being a portion of a large lot originally purchased for another purpose. After seasoning the timber for two years, the posts were made into the form in which they were to be placed in the ground, and then kyanized. Six years ago, in 1885, an examination of the posts was made, when many of them were found to be more or less decayed below the surface of the ground, and a number of them were nearly rotted off at the ground surface, while a few of them were remarkably well preserved, and are so now. Occasion was then taken to strengthen the decayed posts by spiking pieces of kyanized two and one-half inch spruce plank, six and one-half feet long, to

PLATE V.

Pawtucket Street Bridge over Northern Canal, Lowell, built in 1850 of Northern White Pine, kyanized. No repairs made, except renewing surface plank, until 1882, when the lower ends of some of the braces were found so much decayed as to require renewal of that part of the lower ends which rested on the masonry.

Photographed in 1891.

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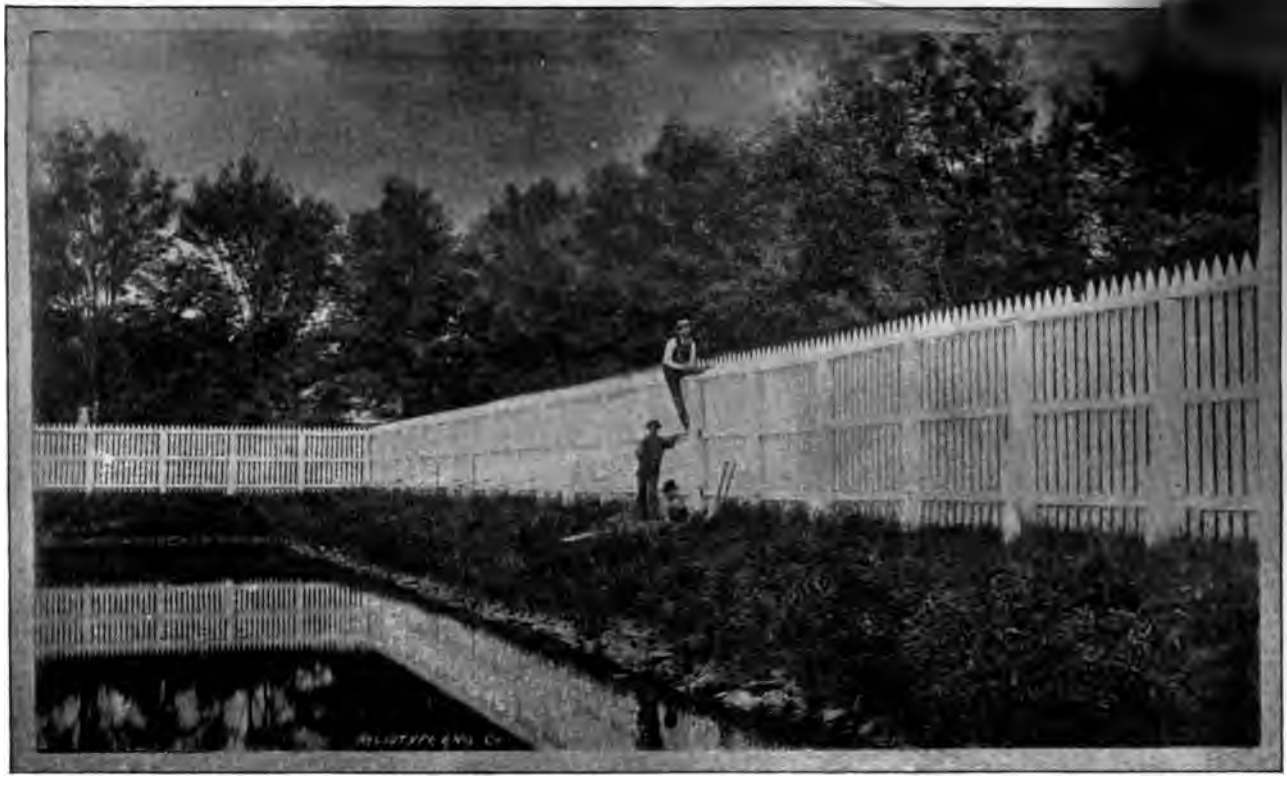
PLATE VI.



Kyanized fence around Reservoir on Lynde's Hill, Lowell, Mass., built 1850. In 1885 some of the posts were reënforced near the ground line by 2 1-2 inch kyanized spruce plank 6 1-2 feet long.

Photographed in 1891.

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PLATE VII.

Kyanized Spruce post, 6″ x 8″, in Reservoir fence, Lynde's Hill, Lowell, Mass., since 1850.
Dug up and photographed in 1891.

the sides of the posts, at and near the ground. The fence has been whitewashed with lime a number of times since it was built, and this undoubtedly has had a tendency to preserve the part above ground, independent from the kyanizing process. This example is as good a one as can be found in this vicinity, and clearly demonstrates the economy of kyanizing spruce timber that is to be placed in situations which expose it to decay.

Spruce posts may last from six to eight years, if placed in the ground in their natural state, depending much upon their condition. If full of sap, they would decay very quickly; but if well seasoned before they are placed in the ground, they would last several years longer. In the case of the reservoir fence above mentioned, the kyanized posts lasted thirty-five years before any repairs were made. The fence is now in good condition, and will wear for a number of years more.

Plate VII. is a view of one of the spruce posts in the same reservoir fence, taken up very recently at the point indicated in Plate VI., where the three men are at work. It is a remarkably good specimen of kyanized spruce, which after forty-one years of service remains apparently as sound and good as the day it was put in the ground. It is exceptional, however, as most of the posts in the reservoir fence are more or less decayed near the ground line, although the parts above and below the surface are apparently quite sound.

The cost of kyanizing depends mainly upon the cost of corrosive sublimate, which is one of the important products made from mercury. The present charge for kyanizing at Lowell is eight dollars per thousand feet board measure, which gives a small profit, and enables the company to keep the works and railroad tracks leading to them in good running order. The amount of lumber treated at Lowell, including what has been done for outside parties, averaged about 750,000 feet board measure per annum for the past six years, and represents about one-half of the capacity of the works.

Powers & Weightman, manufacturing chemists of Philadelphia and large manufacturers of corrosive sublimate, in a recent interesting communication, give some facts which are here quoted: —

"Quicksilver is largely produced in Europe and also in this country. There are various causes for the fluctuation in the price of quicksilver. The Spanish product is controlled by the Rothschilds, who frequently have opportunities for manipulating the market in their own interests; then, again, the price is affected by the law of supply and demand, although there never is an absolute scarcity. The prices in this country are governed very largely by the prices ruling on the other side. The present rate of duty on quicksilver is ten cents per pound on what is imported, and is about double what it was prior to the passage of the present law."

The prices paid for corrosive sublimate at Lowell, when purchased by the ton, for the past few years, are as follows: 1876, fifty-eight cents per pound; 1880, forty-three cents; 1885, fifty-one cents; 1886, fifty-seven cents; 1888, sixty-eight cents; 1890, seventy-four cents; 1891, sixty-six cents.

In Lowell it is found that lumber takes up from three to five pounds of corrosive sublimate per thousand feet board measure, depending upon its condition; and corrosive sublimate, being soluble in water, will penetrate farther in green lumber that is full of moisture than in dry lumber, although lumber in the green state will not take up as much of it as when it is dry.

Two vats or tanks are used at Lowell for kyanizing. The larger one measures fifty-two feet nine inches long, eight feet five inches wide and four feet six inches deep. It will hold from twelve to fifteen thousand feet board measure of timber, depending upon the dimensions, and it is of ample size to hold an ordinary car load of timber. This tank was constructed in 1887, of brick, and, to prevent any leakage, all of the bricks in the inside courses of the walls and floor were first dipped and then laid in pitch made from coal tar at a temperature of about 300° F.

Corrosive sublimate is an acrid poison, and many persons have predicted that the health of workmen engaged at and about the tanks would be injured by it. Such has not been the experience of the workmen at Lowell. Since 1848, when kyanizing was first introduced there, not a single case of serious injury from poisoning is reported, but on the contrary, workmen who have been employed for years believe that certain benefits are derived from it, such as the rapid healing of sores, prevention of fevers, and the healing and strengthening of weak eyes.

A report on the preservation of timber was made by a special committee of the American Society of Civil Engineers, and published in 1885. It covers five years of investigation, and embraces a clear and comprehensive statement of all modern methods adopted in various countries.

The indications are that no single process seems to be adapted to every situation where timber is exposed to decay, and that failures sometimes occur. Timber has been known to decay in a comparatively short time after treatment, and the cause of it cannot always be found. Manufacturers of leather experience the same trouble, and lose many hides from failure in the treatment, which cannot readily be accounted for. Timber treated with salts should not be placed in very wet situations, because the salts are easily soluble in water, and are liable to be washed out. The oils are much less soluble, but the cost of treatment is greater.

Whether or not our railroad corporations comply with the rules of economy in using wood ties in their natural state, which usually last from six to eight years, rather than, methods of treatment, preserving them to last from times that length of time, is a matter that has r receiving earnest consideration. The steadily r and the growing scarcity of timber will soor consumers to resort to methods of preservat a much greater extent than is done at the pre

In a recent address delivered by Mr. John Doyle to the Roadmasters' Association of America, it was stated that 73,000,000 sleepers were used annually in the United States, a quantity which is double the possible permanent production of the present timber areas. The woods used vary, and are laid without being creosoted or otherwise treated by a preservative process. The average life of the various woods used as sleepers is as follows: —

KIND OF WOOD.	Average Life. Years.
Oak,	8
Black cypress,	8
Chestnut,	7½
Red cedar,	7
Red spruce,	6
Hemlock,	4½
Tamarack,	4

The PRESIDENT. Will the members of the Association take up the discussion of this paper before going to the next, or shall we hear the next paper on a kindred subject?

Mr. JOHN BIRKENHEAD. Mr. President, I can appreciate what has just been stated in regard to the preservation of wood that has to be laid in damp places. I have had a little experience in that line. About sixteen years ago I put a costly fence about six feet high around my house lot, made of the first quality of sheathing, matched, and capped with two coats of paint, both sides. The color of the fence was cream; of the posts red. The latter were burned or charred before setting; were of six to eight inches in diameter; and of chestnut. I was highly pleased with it. I thought it would last as long as I should; but, to my surprise, in two years after, I noticed that every post was surrounded with what looked like sawdust. On examination I found that some kind of grub was eating the posts at the ground level; and instead of having a six or eight inch post, in some cases I had but a two-inch post. In less than a year's time my fence would have been lying flat on the ground. I then put on my thinking cap. I thought of kerosene oil. I never knew of anything that could live on it; but thought it might not be enduring; but petroleum, having the same properties and having more body, would be better. I did not know how to obtain it in its crude form; but I had a barrel of black paraffine lubricating oil. I took less than two gallons of that, and poured it around each post, seventy in all, fourteen years ago; and each post, at the ground line, has not changed a particle. There is one end post I overlooked, as it was boxed, or sheathed in, out of sight; that was eaten off years ago, but the others keep it well in position. It is my opinion that all decay is life, either of its own producing, or otherwise; and the properties of petroleum make it a great cleanser; it kills life, and destroys its germ. It mixes well with coloring or paint; and I think the time is coming when it will largely replace linseed oil. It dries rapidly, for outside work, and

must preserve the wood. I have no doubt of its efficiency, used on wood work in wheel pits, or any other place where wet or dry rot is liable to occur; such as floors near or on the ground. Kerosene, or burning oil, is now being largely used for cleansing furniture and wood work in houses.

The PRESIDENT. There is one question I would like to ask Mr. FRANCIS. On page 18 you say that the corrosive sublimate will penetrate farther in green lumber that is full of moisture than in dry lumber; although lumber in a green state will not take up as much of it as when dry. Would you recommend green lumber for kyanizing rather than dry lumber?

Mr. FRANCIS. Well, that is one of those things there seems to be no absolute rule about, and it seems difficult to say. I have shown an instance here of a post that had been kyanized that has been in the ground forty-one years. I consider that as good a specimen of kyanizing as can be found anywhere. That post was purchased two years before it was kyanized, and it was purchased for another purpose; and, having that timber on hand, it was allowed to be seasoned two years before it was kyanized. Then it was kyanized and put in the ground, and it was in the ground forty-one years, and when it was taken up not very long ago it was found to be perfectly sound. That was a remarkably good specimen. Now, I think under those circumstances it would show that it might be well perhaps to season the timber pretty well before it is kyanized. That is my own individual opinion; but when you come to speak of the exact fact, whether it is better to kyanize green lumber or better to kyanize dry lumber, I do not think that anybody is able to say whether it would be better or not. Most of the lumber of the Locks and Canals Company comes in a green state, and of course they have to kyanize what is sent to them; but sometimes we have lumber sent to us which is unsound. That lumber cannot be preserved, and for that reason we throw it out. There was something like four hundred thousand feet board measure of spruce sent to us from the

city of Boston for the new Cambridge bridge; four-inch plank, spruce. Well, that is a pretty large quantity of timber. Some of it came to us unsound, and it was thrown out. It is no object for us to throw out any lumber, it does not interest us one particle; but at the same time people who are interested in the preservation of timber should be careful to see that lumber treated in that way, or by any other process, is good to begin with. That is one of the secrets of its success.

Mr. S. N. BOURNE. What kind of wood is that post you speak of having been in the ground so long?

Mr. FRANCIS. That is a spruce post.

The PRESIDENT. In 1882 the Pacific Mills had occasion to lay a basement floor in the main mill, and about two hundred thousand of spruce plank were sent to the Locks and Canal Company for kyanizing. That floor was laid. The plank were laid upon sand and fastened to six-by-six timbers. They were bedded in the sand, and the level of that floor is a little below the level of the ground outside of the mill walls. The plank that have been examined since that time, and some have been examined this year, show the plank and timber to be perfectly sound to-day, and the floor was laid about nine years ago. It is not a moist place. In many spots I think you would find the sand perfectly dry under that floor. There are places, however, where there would be moisture. We found that the plank were in such good condition this year in that place that we have used more of it for bridges and in other places since we bought the first lot. If there are no further questions to be asked of Mr. FRANCIS, we will take up the next paper.

Mr. ROBERT MCARTHUR. I would like to ask Mr. FRAN what kind of wood he would recommend for covering b

Mr. FRANCIS. We recommend softer wood, usually Spruce is the kind that comes to us more than any oth

The PRESIDENT. We will now proceed to the ne by Mr. SAMUEL D. CRAFTS of Boston, on Wood Vul

WOOD VULCANIZING.

By Samuel D. Crafts, Boston, Mass.

Having been invited to address you on this subject, it gives me pleasure to comply, especially as anything which tends to the preservation of our fast-depleting forests is a matter of great importance and interest to all.

It is not, however, the broader view of this question which is of present moment to us, or in the discussion of which I will take up your valuable time, but the preservation of wood by the process carried on by The Haskin Wood Vulcanizing Company of New York, at their works, foot of East 19th Street, in that city.

While efforts toward prolonging the life of timber may have claimed the attention of former ages, it was not until the present century that anything practical was attempted in this direction. Knowing the antiseptic powers of corrosive sublimate, John W. Kyan reasoned that, if he could but remove the sap and fill the pores thus emptied with this salt of mercury, that wood must be indefinitely preserved. Others followed, with the same idea of getting rid of the decaying elements of the sap; and creosote, sulphate of copper and other chemicals have lent their aid to the bringing about of the desired result. The principle of all has been the same; viz., the injection into the vessels of the wood of some mineral material, which, by

combining with the albumen of the woody tissue, prevents its decomposition and gives it a foreign character.

Great credit should be given to pioneers in any line of improvement, not only from the actual benefit derived from their researches, but from the fact that new heads and hands are enlisted in the perfecting of the new ideas, or in the evolving of new methods of producing the desired results.

This process of vulcanizing deals with methods entirely overlooked in the scramble for something with which to stop nature's tendency to decay. It has been found that wood has in it the elements to preserve itself. Heat, the great chemical agent of the universe, has been called to our aid, and by its intense application not only are the germs of decay destroyed, but from its chemical action antiseptic substances are evolved which render decay impossible, even if any life were left in the fungi-breeding sap. It is a fact beyond dispute that intense heat destroys the vegetable principles of the sap, and with it all the germs of decay.

It is well known to chemists that wood contains fifty-three per cent. of liquid matter called sap, and that, if the wood is placed in a still or retort under three hundred to five hundred degrees of heat, the sap flows off in the form of an oily, tarry, resinous, antiseptic liquid, which the chemist separates into pyroligneous and acetic acids, wood alcohol, creosote, and a dozen or more minor chemical constituents seldom heard of in commerce. This result is all produced by the simple application of a high degree of heat to the contents of the wood.

This being a well-established fact, it is very evident that the vulcanizing process, using the same degree of heat, produces precisely the same chemical change in the sap; but, being prevented by the application of an atmospheric pressure of one hundred and seventy-five to two hundred pounds to the square inch, nothing is allowed to exude from the wood while subjected to this high temperature, and it becomes thoroughly filled with the newly formed antiseptic. The wood is subject

to this extreme heat for hours, the liquid permeating the fibres of the wood through and through, the albumen becoming coagulated and the pores filled with the new substance. The wood is then allowed to cool slowly, and by the solidifying of its gums and resins its fibres are made more cohesive, and, as it were, cemented together. At no time in this process is there any possibility of a weakening of the fibres by the pulling apart or opening of the pores, as no vacuum is created, but, on the contrary, the fibre of the wood is kept in place by the intense pressure which is maintained until the lumber is cooled. It is thus that the lumber has been increased in strength, for there has been no separation or straining of the fibre. The fibres become more rigid in their relation to each other, the elasticity is increased, and the resistance to crushing force and transverse stress very materially augmented, facts which have been proven by extensive laboratory tests. (Reference is made to tables herewith appended.) The wood also becomes more uniform in its character, and this is caused by the forcing of the contents of the wood, when in its fluid state, throughout its pores.

We have stated the theory, now let us examine into its practical results. The works have been in operation nine years, and we have yet to learn of the least evidence of decay in a single piece of vulcanized wood. Spruce ties which have been subjected to the severest tests for nearly nine years, being covered in the ground (made land) in the tracks of our yard and exposed to extremes of moisture and heat, on being taken up last spring were found to be as sound as when originally laid, and do not show the slightest tendency to decay; and, where there was a crack in the wood, which, as you all know, is where decomposition frequently first sets in by reason of its holding the moisture, there was not the thickness of this paper in discoloration even. Vulcanized yellow pine ties which have been in use in the switch yard of the New York Central at the Grand Central Depot for seven and three-quarters years do not show the least tendency to decay, and even the sap wood is in

perfect condition. Vulcanized yellow pine ties which have laid on the main track of the Erie Railway for over eight years are as sound as though laid but yesterday.

In these cases cited the wood is as bright as when cut from the tree, and has lost none of its aromatic fragrance. Its specific gravity is apparently about the same as when first laid; and the nature of vulcanized wood is that it does not continually grow lighter and lighter, as in the untreated lumber, but the specific gravity remains fixed, being very close to that of green lumber. In yellow pine and rich resinous woods it is increased some ten per cent. This permanence of the specific gravity is maintained for years, the fact being, as practically demonstrated, that vulcanized yellow pine, after exposure to the elements with the deteriorating influence of wind, rain, heat and cold, becomes more dense, and, as one of our large customers states, is in better condition, than when treated nine years ago, being tougher, and its strength increased in its resistance to the wearing and crushing effect of heavy traffic.

Owing to the unchanging character of the wood, its spike-holding qualities are remarkable. The spikes in the ties which have been referred to have *never* been drawn, and are in their original position still, holding as firmly to-day as the day they were driven.

In buildings where the floors and beams are subjected to steam and constant moisture, as in many of your dye houses and other places, the fact is apparent to you all that decay arises because the steam and heat induce the fungous growth, being the special elements in nature conducive to it. The chemical ingredients in their coagulated state, as in vulcanized lumber, are not easily soluble by moisture under heat, and the strength of the timber remains; while the contrary is the fact in timber in its natural state, which becomes weaker and weaker, until expensive repairs are necessary. We all know how important a continuance of routine is in a well-organized mill, and hence how greatly the cost is increased by a disturbance thereof, saying nothing of the cost of replacing.

Vulcanized wood, from its density and increased specific gravity and cohesiveness of fibre, makes the very best of floors; as they wear better, and will not brash up. This comes from the changed nature of the wood.

For interior finish a rich antique color can be produced by vulcanizing when desired, which is uniformly even throughout each piece, and the lumber partakes of a higher degree of finish in less time. This is owing to the cohesion of the fibre and the filling of the pores with the natural gums and resins of the wood.

In a paper of this kind, limited as to time, you cannot expect to be fully informed as to all the details either of our process or of its results; but we trust that we have gained your attention to this wonderful discovery, and we should be pleased at any time to further personally assist you in your investigations as to its worth, at either our Boston or our New York office.

Records of Tests by Transverse Stress, Mechanical Laboratory, Department of Engineering, Stevens Institute of Technology.

Yellow Pine Untreated.	Laboratory Number.	Dimensions.		Depth.	Deflection, Actual.	Breaking Load.		Total Deflection.	Specific Gravity.	Modulus of Elasticity.
		Distance between Supports.	Breadth.			Absolute P.	Modulus.			
No knots or cracks, .	3,035	40	1.96	1.98	.030	1,570	12,273	2.00	729	1,752,000
No knots or cracks, .	3,036	40	1.96	1.98	.031	1,585	12,391	1.57	717	1,694,000
No knots or cracks, .	3,037	40	1.97	1.96	.030	1,540	12,000	1.67	704	1,839,000
Average, . .	–	–	–	–	–	–	12,555	1.75	715	1,761,000
Yellow Pine Vulcanized.										
No knots or defects, .	3,041	40	1.96	1.95	.028	1,700	13,420	1.50	794	2,058,000
No knots or defects, .	3,042	40	1.96	1.96	.030	1,630	13,000	1.60	793	1,806,000
No knots or defects, .	3,043	40	1.94	1.94	.029	1,735	14,310	1.75	793	1,947,000
Average, . .	–	–	–	–	–	–	13,580	1.62	793	1,937,000

The above tests were made by Prof. R. H. Thurston.

Abstract from report of Alfred P. Trautwein, dated New York, Nov. 20, 1884: —

"Test by compression on the Olsen Machine of the Stevens Institute, Hoboken, upon yellow pine.

"These were made upon samples of three different lengths cut out of the plank, as shown, and 3″, 4″, and 5″ in length respectively; the ends were accurately squared, and the cross section of the sample was approximately one square inch."

A. Three-inch Samples.

		lbs.			lbs.
A.	Natural, crushed at	5,300	A	Vulcanized, crushed at	7,750
B.	Natural, crushed at	6,500	B.	Vulcanized, crushed at	7,100
C.	Natural, crushed at	5,900	C	Vulcanized, crushed at	7,500
	Average,	5,900		Average,	7,450

B. Four-inch Samples.

		lbs.			lbs.
A.	Natural, crushed at	5,100	A.	Vulcanized, crushed at	7,250
B.	Natural, crushed at	5,800	B.	Vulcanized. crushed at	7,000
C.	Natural, crushed at	5,500	C.	Vulcanized, crushed at	7,100
	Average,	5,483		Average,	7,116

C. Five-inch Samples.

		lbs.			lbs.
A.	Natural, crushed at	6,500	A.	Vulcanized, crushed at	7,350
B.	Natural, crushed at	6,000	B.	Vulcanized, crushed at	7,000
C.	Natural, crushed at	6,500	C.	Vulcanized, crushed at	7,600
	Average,	6,333		Average,	7,310

	lbs.
Average all compression tests, natural,	5,900
Average all compression tests, vulcanized,	7,294
Increase,	1,394 = 23.6 per cent.

[Copy.]

School of Mines, Columbia College,
49th St. and 4th Ave., New York, Feb. 25, 1890.

My Dear Sir: — I have examined the sample of oak wood, preserved by your process, which you placed in my hands. I find that

it is entirely different from the original wood, of which I also examined a sample. The treatment to which the oak has been exposed has effected a radical chemical change in its character, and it now contains 11.91 per cent. of materials, most of which have resulted from the action of heat. These I have succeeded in separating into: —

	Per Cent.
Neutral oils, turpines, etc., ...	0.36
Phenols, ...	0.77
Resinous acids and other bodies, ...	10.78
	11.91

A very considerable portion of this 11.91 per cent. of material consists of antiseptic and preservative substances, which will act to protect the wood from decomposition and decay. They have also radically changed the appearance of the wood, producing what would have otherwise required a long lapse of time. The wood before treatment does not contain the above-mentioned substances, and would be liable to be attacked by microscopic fungi, and to undergo decay when exposed to air and moisture.

In conclusion, I would say that your process seems to be a remarkably simple and effective one for improving the appearance, and very greatly increasing the durability, of timber, and protecting it from the agencies which result in destroying, by decay, timber which has not been treated.

Very sincerely yours,

C. F. CHANDLER, PH.D.

To MR. SAMUEL E. HASKIN,
40 Wall Street, New York City.

The PRESIDENT. I shall be glad to hear further from the members.

Mr. JOHN BIRKENHEAD. Mr. President, I would like to say a few words further in regard to this petroleum. I incidentally remarked that I had another piece of ground opposite my house that I fenced in. I put a wire fence around it, one of these twisted wires, and put down cedar posts in this case which were about four or five inches in diameter, with bark on them,

and tapering off on the top, and painted them red, which gave them a very rural appearance, and I liked it very much; but it appeared that the moisture would get in under the bark and separate it on the top; and make it disfigured after it had been down a few years. What makes this fresh in my memory is, that it was only last week I was stripping this bark off and painting it. I took this common black oil, and mixed it with a little linseed oil, and mixed the paint with the common black oil, and painted these posts over, and it seems to dry in very quickly. Of course it does not give a lustre, because it soaks into the wood, and that has a very preserving effect.

Mr. Francis. Mr. President, I have been very much interested in this paper of Mr. Crafts. I see that the samples which have been tested for strength were of yellow pine, and undoubtedly that kind of wood seems to be well adapted to this process; that is to say, it has considerable resin in it, and other substances which are considered antiseptical themselves after they are properly treated. Now, in regard to the method of treating that lumber, he has given us no particulars. I understand that it is done in an iron cylinder about six feet in diameter and perhaps one hundred feet long, — something like that. The cylinder, I believe, is wound on the outside with coils of steam pipes, and a pressure of steam of about two hundred and fifty pounds is maintained. That gives a temperature — I am not quite sure as to what the temperature is, corresponding to that pressure, but at any rate they get somewhere between four and five hundred degrees. [The temperature of saturated steam corresponding to a pressure of two hundred and fifty pounds per square inch, above the atmosphere, is not far from four hundred degrees Fahrenheit; and it can be made much hotter by superheating.] Then they apply the pressure of two hundred pounds or so to the wood, in order to keep the sap inside.

Now, I think it will be found that this treatment cannot be given by anybody or everybody. It must be done by experts;

by persons who understand how to do it; and they learn by experience. There is no formula they can follow; and this process, to be successful, I think, depends very much upon the care which is given to the details of treatment.

Mr. CRAFTS. Mr. President, I would like to ask Mr. FRANCIS, and I think he will agree with me, whether this does not apply to almost all processes for preserving timber, — that it must be honestly done? I think that is the prime factor in all this work.

The PRESIDENT. Our next paper was to have been by Mr. FRANCIS P. SHELDON of Providence, but I have not seen him here this morning, and we will have to continue the discussion of the preservation of timber until he comes, or take up some other question.

The PRESIDENT. Mr. MESSENGER will say a few words upon the oil fuel process which he has been using for some time past, and no doubt will entertain you with his experience.

Mr. F. M. MESSENGER. Mr. President, I will say that I did not come here to speak upon the oil fuel question, but I was a little disappointed, when I received notice of the meeting, to see the papers that were going to be read, because I understood that we were to have a paper on oil fuel; that is, I got that impression, and I was very desirous to hear one. I will say I did not expect to speak about it myself to-day. We have been using oil fuel a little over three years in our mills, but I have no data to give you of the results that we have attained. I hardly think that with our system of burning we attain as high an efficiency as they do with the Archer process, although I have not seen that process; but, from the paper we heard here last spring, I should judge they have a better system than we have. We use the Reed burner, which is a simple process, and requires little attention and care. To vaporize, we use steam from the boiler. The Standard Oil Company's expert claimed to use but five per cent. of the steam

generated by the boiler, to vaporize the oil with; but in our experience, in some tests we have made, we think it takes a little more than that. And that led us to examine a little into the merits of the Aerated Fuel Company's process at Springfield; but in the test figures which they sent me it did not seem to me that they attained any higher efficiency than we had done; and, as I understood it, — although I have not investigated very thoroughly the plan for using that process, — it would be quite expensive. That is, I understand they use an air compressor, which takes considerable power to operate it; and the first cost of the plant is quite expensive. We put in our plant very thoroughly, so far as our piping of the tanks is concerned. We put in two large tanks ten feet in diameter and thirty feet long side by side. We excavated so that we set the tanks down pretty well into the ground; that is, we dug a cellar and laid cross walls with cement bottom — I think, four cross walls, equally divided — and through those we laid three stringers of railroad iron under the tanks, to prevent any settling. We discharge the cars directly into these storage tanks, as we call them. Then we laid a pipe to our mill yard, which is about six hundred feet distant. These tanks we housed in with a brick building, and laid our pipe line through to the mill yard, where we also built a small building for our immediate supply. Here we set a small tank above the feed tank to measure the oil accurately; so at any time in the day we are able to take our reading and know how many gallons of oil we burn. In that respect we can keep pretty close account of the fuel, and we do not have any heavy shortages to charge up as we used to have with coal. Our coal used to shrink for some reason or other in our coal shed. As I said, I have no data with me or figures to state just what results we are obtaining, but our impression is that, as regards the money that we pay for fuel, there is a very slight difference between the oil and the coal. Our coal-dump being several hundred yards from the boiler-room, we were obliged to cart all our coal to the boilers, and take away

our refuse matter, ashes, etc. With oil we save this expense, and we make a considerable saving, in labor also, in our fire-room. At the present time we generate about twelve hundred horse-power of steam at our largest plant, where one fireman takes care of it with perfect ease and comfort, and we have to stir him once in a while to keep him from getting lazy. I understand Mr. THOMAS of Lowell has experimented considerably, and I think he has used different processes of burning oil; and I think perhaps, having more recently installed his plant, his memory may be better than mine, and I would like to have him called upon.

The PRESIDENT. I understand you to say the cost of material is about the same, whether you use coal or oil?

Mr. MESSENGER. That is our experience. I will say we always burn broken coal at our works. We might perhaps have burned a coal that would have been a little cheaper in results than what we did use.

The PRESIDENT. Anthracite?

Mr. MESSENGER. Anthracite, yes; and our comparisons are made with that.

The PRESIDENT. Mr. THOMAS, we will be very glad to hear from you.

Mr. E. W. THOMAS. I am quite unprepared to give any figures. I can simply substantiate what Mr. MESSENGER says in regard to the first cost of the fuel. It stands us about the same. We make a saving in the handling and carting of ashes, in labor, and in the appearance of our boiler-house. I had intended to read a paper here to-day giving forth some facts; but as a matter of fact I am not prepared to; certain suggestions I wanted to make, but I could not prepare them in time to incorporate in a paper.

The PRESIDENT. What process do you use?

Mr. THOMAS. We are using the same as Mr. MESSENGER,—Reed's burner, which is a very simple process.

The PRESIDENT. Mr. FISH, will you give us your experien in your process?

Mr. C. H. Fish. We are still running about six hundred horse-power upright boilers, and we have been running now since a year ago last August, when we started; but have not made any tests for perhaps seven or eight months; but I see no reason for changing the figures which were given at the meeting here in the spring. Our evaporation, I think, ranges from sixteen to perhaps eighteen pounds maximum in our regular running, and we have never had any trouble at all with the process. This is the Archer process. As far as the first cost and economy goes, why, figuring from that evaporation, you can arrive at your own conclusions. Our coal used to cost us nearly five dollars, delivered at the mill. This year coal is very much cheaper there, but we have not bought any, so I do not know just what it will cost us. Our tanks are underground without any foundations at all; that is, we dug a hole deep enough to bury the tanks below the level of the boiler-house floor, and the tanks are held by brick cradles or shoes bricked up against them to prevent their shifting, and connected with the pipes; and the whole is covered up underground, so the road goes right across over the top, and there is no knowing where the tanks are. We left the hole open long enough to determine whether the tanks were going to leak any or did leak any, and when we found they were all right, covered them up.

Mr. Messenger. I would like to ask Mr. Fish if they did not vent their tanks at all.

Mr. Fish. Yes; we had to vent them because of running oil into the tanks. We passed a pipe out of the top. Each tank is tapped with an inch hole, and all connected with one main which runs to one side of the roadway, out of the way, and an upright pipe sticks up six or eight feet; but that is the only vent except in connection with the pumps in the boiler-house.

Mr. Messenger. In our tests, as I remember, the best results we got were a little over seventeen pounds of water to a pound of oil, but our coal was costing at the time two dollars and a half per thousand pounds; that would be a little over five dollars a ton for coal delivered on our dump.

The PRESIDENT. The secretary informs me that Mr. SHELDON's paper is in the hands of the printer, and it was promised to be here about noon. Shall we stay here any longer, or shall the meeting be adjourned? There is no further business that I know of.

Mr. O. S. BROWN. Mr. President, from time to time we have parties come to us with some patent ingredients or some secret substance they will put into our sizing, from which they claim to get great results. My experience with it has been but very little. Some have tried it; and if there is any good thing in the market, I would like to know what their experience is with it.

A MEMBER. Dressine is the best article for use in sizing.

Mr. T. B. WATTLES. I will say in reply to that, that starch dressine makes yarn smooth, less chafing off of the sides; that is, yarn is as elastic, and more so, we think, than it is without it, and there will be less breaking in the looms in consequence. I do not know that there is anything more that I care to say about it.

Mr. BROWN. Mr. President, Mr. WATTLES has not answered the question yet, by telling why.

Mr. WATTLES. I do not want to tell the gentlemen that. I think the best way to answer Mr. BROWN's question would be to do just what I often do, — go to the mill and stay as long as I want to, until I have sized the yarn satisfactorily.

Mr. MESSENGER. There are sizing compounds that have a tendency to moisten or serve the purpose of moistening the atmosphere, so that the yarn does not get dry. Now, if there is such a thing as that, it must be quite an advantage in the saving of cost for vapor steam, and in lessening heat, so as to make the rooms more comfortable for the operatives. I have had no experience that I can give you, but I would like to know if any one has had an experience with any kind of a compound that does serve that purpose to any extent whatever.

Mr. BROWN. I think, Mr. President, there must be several men here who have had quite an experience with various sizings, and things, the names of which I cannot give, for I do not know how many have been in to see me and told me of places where they have used them with great success; but I have never talked with any agent who has used it. If there is anything in the market, I would like to get it. I tried a cask, and did not see that it did me any harm.

Mr. WATTLES. Mr. BROWN remarks that he tried a cask, and it did not do him any harm. I will say if a person who has not tried dressine will try it, he will find if it does not do him any good it won't do any harm. I have used more perhaps than any man in New England. I have great faith in it, and believe it to be a good thing.

Mr. BROWN. That is not the question, Mr. WATTLES; but you take and put that in, so you won't have to use any steam. You might use it in the winter, but what would be the effect in dog-days?

Mr. WATTLES. I think you want to use more of it in winter than in summer.

Mr. BROWN. We are making some sateens. Wouldn't it be a dangerous thing to use it there?

Mr. WATTLES. No, sir. There is something to put into it to prevent any moulding or mildew.

The PRESIDENT. Antiseptic?

Mr. WATTLES. Yes, sir. And, in proof of that, there are a good many men here who have discovered what that antiseptic is, and have used it right along.

The PRESIDENT. Mr. MESSENGER has made a pertinent inquiry. If any member has received any benefit from any of these sizing compounds, there is a good opportunity to state it.

Mr. W. J. KENT. Mr. President, I have had quite an extensive experience in the use of sizing compounds; and, as we have two hundred varieties of goods, it becomes necessary a great many times that we should look after them pretty

closely; and we make cotton cloth all the way from twenty-four picks to the inch up to two hundred and fifty. Now, I have found out this one thing, that the less you use of these compounds the better. (Laughter.) Notwithstanding that, Mr. WATTLES has made some very good experiments in our mill, and we are now using his compound; but it makes all the difference in the world what kind of goods you want it for. Mr. BROWN asks this question of Mr. MESSENGER. Now, you take our fine goods, where we use sixty warp and ninety filling, or about those numbers, and we don't want any of it. We use simply tallow and starch and water; the slasher-tender had an idea that he must put in a little turpentine, but it does not amount to *that* (snapping his fingers). I know there is a great deal of prejudice to be overcome in this sizing business, as Mr. WATTLES well knows. We have had one compound which we consider very good. Mr. WATTLES puts in another compound, and he has the barrels all labelled, and all put up in the same manner. My man thinks to-day he is using the other kind when he is using Mr. WATTLES'. (Renewed laughter.) I asked him the other day to take me where Mr. WATTLES' compound was. He took me there and said, "There is the Victoria, and this is Mr. WATTLES'." I have not put any Victoria in the sizing for several months; but I do not propose to inform the overseers. But I cannot agree with Mr. WATTLES on this one point; and that is, we want the humidity of the atmosphere in the room just the same as we would if we did not use it. Our temperature is generally about eighty-seven and our humidity ranges about eighty. Then we get the best results.

Mr. MESSENGER. I am very much interested in this discussion, because I am just passing through some experiments in this line. I will say, I tried dressine in our mills. As Mr. BROWN says, we found it did not do us any harm. Another man sent a preparation to put in our sizing, and, in fact, we have two or three kinds. He quoted a good many mills that use it (I am not speaking of Mr. WATTLES' compound), and I

suggested they were all coarser mills. Yesterday my overseer called my attention to the fact that, while the yarn seemed to be strong, the warp did not break, and it ran well; at the same time the picks seemed to go in very hard, and the yarns felt like ropes. I had to take both hands to the rim-wheel to turn the loom over the pick. There was a marked difference between it and our regular-sized warps. It looks as though *that* is something we do not want. Notwithstanding it seemed to make the yarn feel very strong, it was not smooth; you could not put the picks in without straining the cloth up very tight indeed, to the extent that we narrowed down the width of the goods.

Mr. KENT. I should advise the manufacturers here present, before they go into any of those things, to look at the cost. We got into trouble once.

The PRESIDENT. The increased amount of power which Mr. MESSENGER states is something which I never thought of before.

Mr. MESSENGER. I will say that the warps we slashed with the dressine did not feel like that; we did not notice anything of the kind, but they seemed as smooth as our regular size, but with this particular preparation, it was remarkable, to my mind.

A MEMBER. If Mr. KNIGHT is present, from what I have heard of him I think he has some facts in the case. I am told that in one corporation they used these various ingredients, in the Amory perhaps; and then in another, the Linden, they use simply starch and tallow; and, while they may cook it perhaps a little differently, they do not discover any very material advantage of one over the other. I do not know whether Mr. KNIGHT is in the room or not, but if he is, I think he can give us some facts right to the point.

Mr. A. F. KNIGHT. Mr. President, I did not come here to give any information upon the subject of sizing. I cannot give anything in detail, because I am not prepared to do so, but I think that I can coincide with some of the things that

Mr. KENT has said; that perhaps if you were to make the goods out of the fine yarns you will find that you do not need much of anything except tallow and starch and water. My personal opinion is that it makes a good deal of difference how you prepare your size. If you are using corn-starch, as we do, although a good many of you think it is absolutely necessary to have potato starch, but we use it because it is cheaper, I have found we do not use any more of the corn-starch than we do of the potato starch, although it costs a good deal less money. We use it in the Amory Mill, where we have sixteen hundred looms, and two slashers prepare the warps for sixteen hundred looms. We use some dressine, perhaps not near as much as Mr. WATTLES thinks we do. (Laughter.) We do one thing which we think amounts to a good deal. We boil our sizing a long time, I won't tell you how long, but we boil it a good while. You need not be afraid of boiling it too long. You will have to put in a little more starch to begin with; but, if you keep account of the number of pieces of goods you size, you will find it does not take so much starch to size a cut of yarn after boiling it a long time as it does when you do not boil it a great while. Mr. THOMAS can tell you something about that. As I said, we used dressine in the Amory Mill. In the Langdon Mill we do not use anything except a little tallow, water and corn-starch. We have goods similar to those Mr. KENT spoke of, — heavy goods. The filling is quite heavy and the warp not so very heavy. They are hard goods to weave, and we have questioned whether or no we would be benefited by using dressine, and have thought that we would put it in, but have not yet come to it; and we get about as good results from the looms in one case as we do in the other. I am of the opinion that we can get along if we do not put in anything except starch and water. There are times, as you all know, when the sizing will foam; and our experience has shown us that a little turpentine dropped in the size-box of the slasher will stop it. I have found a little kerosene will stop it.

We run our slashers very fast. We do the slashing for sixteen hundred looms on two slashers. We do not think we could afford to have another slasher, and we can get along very comfortably with two. But when some of these fellows that have been to see Mr. BROWN come up to see us, and go into the mill with their sizing compounds and try to do our work by putting in it two-thirds the amount of starch, and only boiling the sizing fifteen or twenty minutes, or bringing it up to a boil without boiling it a long time, they find they have difficulty in drying the yarn, and we have to slow down the slasher. In our mill, before I had anything to do with it, we called a sizing man there, and he spoiled a lot of yarn; the yarn mildewed, because he run it on the beams, wet. He said he would pay for it, but never did. (Laughter.) That is all I have to say.

The PRESIDENT. Can you tell us how many pounds of yarn are used to a pound of starch in the goods you speak of?

Mr. WATTLES. I cannot tell you. We put on about four or five per cent. of sizing. When Mr. WINDSOR was running the mill, he wanted to know of me if I could get him something to put in the size that would allow him to put in another hundred looms without putting in another slasher. After some experiments, we came upon the method that has been used there ever since, and they have been adding three or four hundred extra looms, and have not put in another slasher.

Mr. KNIGHT. While I think generally dressine is a very good thing, we are going to put in another hundred looms, and I do not think it is necessary to continue the use of the dressine to dry the yarn. I think that the merit of dressine perhaps is that they have some sort of acid in it; and I know it keeps the rolls clean, and also keeps the cylinders clean. Then they put in something that has a tendency to dry the yarn, but I do not think it is absolutely necessary we should have it.

A MEMBER. Mr. Chairman, a gentleman came to me a short time ago about sizing called *slashine*, and he said that most of the mills in Fall River and New Bedford were using it with good success. I would like to hear from them.

Mr. KNIGHT. There is one thing in this connection, that is, when these slashing-compound men come around, they all tell you that they will save you so much money on each batch of size that they make. I do not think you ought to stop there in your calculations as to the cost. The better way, I think, will be to keep account of the number of pounds of yarn that is sized by them, and settle it up that way. Then you will find out what it costs; rather than by the cost of a single batch of sizing.

Mr. MESSENGER. Mr. President, while we are on this question, if Mr. BALCH of the Naumkeag Mills of Salem is here, I think he could interest us. He has had quite an experience, not only in sizing compounds, but with a so-called improved method of making size. It is an English invention sold by parties here in Boston, and I have been trying for the last six months to get out to go down and see him. It is a different process in cooking it. If he is here, I think he could give us some very interesting talk on sizing compounds.

(The President made inquiry, but Mr. BALCH was not present.)

Mr. BROWN. Mr. President, haven't you had quite an experience with these various compounds?

The PRESIDENT. The question of Mr. BROWN seems to bring me into the matter. We have used various compounds at various times, but we never have found any that we thought were advantageous. I think we could say, with Mr. BROWN, that they never did us any harm; at the same time, I should not want to say that that settles the matter, so far as sizing compounds go. There are different grades of goods made from what we make, and, while we may not need anything very elaborate in the way of sizing, there are mills that do. We do not need, for instance, to load our yarn very much with sizing; and I fancy that there are some compounds that would enable a person to do that with safety. I saw some goods a few days ago that were increased in weight more than fifty per cent. with some sort of compound; and, when goods are loaded to that extent, it is necessary to

introduce some antiseptic in the sizing in order to keep them from mildew and decay.

QUESTION. Made in this country?

The PRESIDENT. Yes, sir. The use of sizing compounds with us I do not think is of any importance whatever. We size as lightly as possible, using the potato starch unfermented, but cooked, as Mr. KNIGHT says, completely. For No. 28 yarn we put about one pound on to twenty-five pounds of yarn. I do not think that would be enough for some kinds of weaving, but it is with us.

Mr. BROWN. There is one statement that has been made that rather surprised me, that it would be well to use sizing on coarse goods, not on fine. Now, why it should be used on coarse and not on fine I do not quite understand.

Mr. KNIGHT. Mr. President, I will give you my experience on that. In making fine goods out of fifty warp, sixty filling, for instance, one hundred and six picks to the inch, and ninety-six slaie, etc., I have never used any sizing compounds. I simply put in a little tallow and alum. I do not know that it would do any good, but in heavy goods I have used dressine, and it went all right, and so I have not changed. I do not know but it would go all right on fine yarns. Perhaps Mr. KENT will tell us what his experience has been.

Mr. KENT. I can only say this, we have tried the experiment, and we did not get the good results we did from starch or tallow, and did not weave as well; but Mr. BROWN need not be afraid, if he wants to go into these experiments, of being hurt. I had some of these compounds analyzed, and they contained about seventy-five per cent. of water and fifteen per cent. of starch. The remainder is what they do not tell. There is another thing you want to guard against in using some of these compounds. There is a deposit left on the yarn which cuts the harness very badly, and there you will have expense come in which you do not want. We have been through that. I would like to add one more word in regard to what Mr.

KNIGHT said about putting in turpentine to prevent the foaming, and also the alum which he admits he put in. He does not know why, and I do not; but I had a little experience with some fine goods, and I thought I had got on to a pretty good thing. I bought some paraffine wax. We wished to make some very fine sateens, and we put this into the size, and it made the yarn slip over the harnesses very nicely; it moved splendidly. We thought we had got on to something then that was going to last; but the first thing I knew, we had a complaint from some of the parties who bought the goods that they would not take the dye, and wanted some one to come immediately to see what the trouble was. I started on the next train and went to the works, and they laid the goods before me, and I let them tell me the story; and I went home and took that paraffine wax out of that size and we have not had any trouble since.

Mr. BROWN. Mr. President, history repeats itself. I never put any paraffine wax into size, but I gave a girl some paraffine wax, and she rubbed it on the yarn, and I got into trouble by it.

Mr. MESSENGER. I had a little experience of that kind, only I do not hold myself responsible for it. We had a lot of Turkey-red yarn for handkerchief borders. It was injured in the dyeing, and broke very badly in the weaving; there was a bitter complaint from the weavers about it at first, but this soon ceased, and I thought we had outgrown the trouble and that it had not been as bad as represented; but suddenly there was a complaint from the bleachery about the red borders in the handkerchiefs; the color ran and damaged the goods. They sent me samples of the handkerchiefs which I took to our overseer, and he told me that the weavers were bringing in paraffine wax candles, and waxing those red border threads, to make them run without breaking continually.

Mr. H. L. PRATT. I would like to hear from some gentleman running colored yarn. We have had quite an experience with the various makes of sizing compounds. I had some of

them analyzed. One of those that has been mentioned here to-day contained sixty per cent. of water, and when urged to try another lot of it I notified the parties that, Maine being a prohibition State, we did not need to import any water. We have settled down to the use of dressine, and find an actual gain in product by its use. It causes the size to penetrate better and leaves the yarn smooth and nice. We use potato starch and cook it thoroughly.

Mr. G. W. Weeks. We have tried a great variety of sizing compounds, and have discarded them all for simple water, starch and tallow.

A Member. We have used dressine and the Victoria on our work, — I must say the Victoria size, dressine, and tallow and starch and blue vitriol put into the size. I cannot see any difference in all three.

A Member. I have had some little experience in handling size, and I find that what experience I have had conforms very largely to what has been expressed here; that is, that it is more important to have the base right. These ingredients that are added, if they do not do harm, very seldom, I think, do good, in certain classes of weaving. I believe myself that in colored work, such as Mr. Pratt spoke of, it is necessary to have some acid, something to assist in penetrating the thread with the size; but I believe that, if they can be mixed naturally without this being added too strongly, it is better. I think it is a good thing to take the starch and ferment it. I know that is an old-fashioned idea, and a good many will say that is all nonsense; but it is a matter of experience. I ran them side by side, the fermented and unfermented, and I find that the fermented size gives altogether the best results. You will notice one thing in the harness. If you use the unfermented size it leaves the harness dirty, and it will take a boy as long to clean one harness with unfermented size as a dozen with fermented.

Mr. Kent. I would like to ask the gentleman if the fer-

mented and unfermented size were cooked the same length of time.

Mr. ——. I should say they were.

Mr. KNIGHT. How long were they cooked?

Mr. ——. Sometimes we put our size in as much as an hour.

Mr. KNIGHT. Mr. President, I have had experience on gray goods with both fermented and unfermented starch, potato starch and corn-starch; and I think about all that any of us care to get from a sizing is something that will lay the fibres of the yarn, something that will stick to the yarn while it is weaving. I find that the longer we boil our size, the better it is. I have not been able to find the limit. We cook our sizing perhaps an hour and a half or two hours. We have two kettles to a slasher, and keep one boiling until the other is used up; and if we do not boil our sizing, we find right away that there is trouble, but if we cook the sizing a longer time, an hour and a half or two hours, — and I would rather cook it two hours than an hour and a half, — we get the best results. We cook it until it gets thin, and has that blue appearance with which you are familiar. I think you will find that there won't be a great deal of difference between fermented and unfermented, if you boil it long enough. It does not chafe off at the slasher, and does not shed on the floor. I do not think you will have any more trouble with your harness or in the weave-room. I think corn-starch will go as far as potato starch, and potato starch as far as corn-starch; but we use corn-starch because it costs less money. The advantage we get by usir dressine on the two slashers for sixteen hundred looms is t the acid keeps the rolls clean in the sizing box, and also k the cylinders clean, enabling us to dry the yarn. I also t the acid takes the place of fermentation. Fermentation j duces acetic acid, which causes the starch to dissolve n readily. With dressine, the same result is obtained witl the disagreeable features attending fermentation. Nothing

we have used has helped us at all, and I am inclined to think that under ordinary circumstances starch and water is as good as anything, with perhaps a little tallow. I have tried glue, putting in a pound or two of glue; and, as I said, we all thought we derived some benefit from it for a while, but after a while we found no difference, and abandoned it.

Mr. MESSENGER. Does Mr. KNIGHT continue boiling his size in the size-box while it is running after boiling two hours?

Mr. KNIGHT. Yes, boil all the time; keep it hot.

QUESTION. Do you use any acid or vitriol to cut the tallow or impregnate the yarn?

Mr. KNIGHT. No, sir.

QUESTION. You do not consider it necessary?

Mr. KNIGHT. No, sir. We keep it agitated all the while that it is in the kettle while the sizing is being cooked, and after that it is put into the size-box over the boiler, where the boiling continues the agitation; and we use it there.

A MEMBER. My experience has been very much like that of Mr. KNIGHT. At first our boiler boiled the starch for an hour and a half, until that blue appearance came that he speaks of. Some gentlemen have spoken of tallow and dressine. I am using what I have not heard mentioned, — whalesfoot, and also a small quantity of turpentine in each kettle, because I got the impression, whether right or not, that it kept the yarn from sticking on the cylinder, and made it easier to penetrate. I may possibly be wrong, but with me it appeared to be a good thing. I thought I got better results with it than I did without it; but I think the secret of the thing is in boiling it a proper length of time, until that blue appearance comes into it.

A MEMBER. I used unfermented size. The difference in the product was not very much, but there was in the way the goods were handled, and in relation to the condition of the harness, and the looms did not run as well with unfermented as with fermented.

The PRESIDENT. Can you tell how much flyings you get from the loom, and the product of the loom with unfermented sizing?

Mr. ——. I think better results come from fermented sizing than from unfermented. It occurred to me that one point is perhaps established in reference to the matter by the remarks that have been brought out, and that was this, that fermented size does not need to be boiled as much as unfermented, for the boiling of the sizing takes the place of the fermentation. That is a point worth knowing, as Mr. KNIGHT has said; but in the experiments I tried I ran one set of looms on fermented size and the other on unfermented, and I boiled them the same time. Certainly there was a decided difference in that respect; for the harnesses would be all clogged up with the unfermented, while they were running perfectly clear with the fermented. I do not know that I have answered your question now, Mr. President. I could not tell the difference in the flyings.

The PRESIDENT. I wanted to get a statement, if I could, of the amount of flyings made per loom, and the product per loom. We are producing about thirty-five pounds of cloth per loom of the various kinds of cloth, and make less than four ounces of flying per week per loom, using unfermented potato starch, with no dressine whatever.

A gentleman then asked the President in reference to the members obtaining a copy of Mr. SHELDON's paper. The President stated that it was in the hands of the printer, and it had been expected that it would be read at the meeting; [illegible] it would appear in the report of the proceedings of this [illegible].

Mr. E. S. DRAPER. I move you, Mr. President [illegible] extend a vote of thanks to Colonel FRANCIS and M[illegible] for their papers which have been read here to-day. [illegible] we have all been very much interested. Carried.

Upon motion of Mr. MCARTHUR, it was voted [illegible] member have a copy of the paper of Mr. SHELDON b[illegible] published in the report.

Adjourned.

POWER AND SPEED IN COTTON MILLS.

By Frank P. Sheldon, Providence, R. I.

As your secretary remarked in his letter inviting me to present a paper upon the above subject, power and speed are certainly matters of vital importance in cotton manufacturing, and would seem to offer an ample field for statement and discussion. And yet I cannot pretend to be able to present to a body of practical manufacturers like this one anything in the shape of information or novelty, especially in a paper prepared, as this must be, in a broken manner, in the midst of the exacting demands of business, and therefore compelled to rely for material entirely upon such data as I have obtained in the regular course of my work.

In looking over some of my older notes, it has occurred to me that it might be interesting to take a glance in retrospection at the subject of power, speed and production, and make some comparisons between our modern mills and those of a few years ago, and remind ourselves of the great changes that have transpired in these respects within two decades. It may not be instructive, but may afford some light recreation and professional satisfaction at the results which have been accomplished by the ingenuity of New England inventors, and the untiring zeal and application which are indisputably the characteristics of the New England cotton manufacturer.

In the close competition demanded in cotton manufacturing to-day, the test question applied to everything is, Will it pay?

There is one exception to this rule, however: when it is a

question of larger product of yarn by higher speed at the expense of more power, the manufacturer does not stop to ask, What will it cost? In relative importance for economy of production, speed easily outranks power.

The vital point of importance in regard to power is not, as it is in the labor item, to get along with the least possible amount and at the lowest possible cost. The main thing is to have the power and speed, with absolute certainty and in ample quantity, every minute and hour and day of the year. Probably this truism has been most emphatically appreciated during the past dry season by those manufacturers who have water-power mills with insufficient or no auxiliary steam power; and I venture to say that there are not a few of these who, looking ruefully at the weekly reports of diminished product and consequent increased cost, have felt that if they could only have the power, they would not ask whether it took 1.5 pounds or 5.1 pounds of coal per horse-power to get it.

Every manufacturer knows very well that in the cost of making cotton cloth the cost of the power is the least important of all the items. Labor ranks first, interest and depreciation second, supplies third and power fourth. For economical production, therefore, it is the correct principle to pay the greater attention to the reduction of the three larger items, even though it involves the increase of the smaller one. Increase of speed of spindles is by far the most effectual factor in obtaining this result; and hence it is that any increase of speed that can be obtained without other disadvantages is in the line of economy, regardless of the increased cost of power it may involve. The items of labor and interest and depreciation together are fr five to eight times as large as the power item in the best mill. The limit to speed, therefore, will not be ir power, but in the capacity of the machines to without increased waste, or excessive wear and begin to count too heavily in the item of dep observations apply of course to the spinning

High speed in the card-room is of no benefit, and in the weave-room it may be a debatable point in some mills.

As a matter of economy in manufacturing, therefore, it follows that the first consideration in the motive power of a cotton mill should be absolute reliability and certainty of continuous operation at full speed, rather than a fine economy of fuel. We want both if possible, but *must* have the first at any cost; and hence it may be laid down as a principle, that any improvement in the direction of saving fuel, that may involve any possibility of detracting from the first point, is to be rejected without hesitation. In this connection, a field for discussion may possibly suggest itself as to the advisability of adopting triple and quadruple compound steam-engines for cotton mills, with steam pressure of one hundred and sixty to two hundred pounds, which they demand in order to secure the economy of fuel which is of course their only recommendation. Such steam-plants for ships are to be advocated upon entirely different grounds than apply in a cotton-mill plant, and are operated under entirely different conditions. I will not go into this matter now, however, but am free to say that in my opinion there is ground for reasonable doubt upon this point when everything is taken into consideration, and it may be a question whether the net results of the operation of some such plants which have been installed will not ultimately be disappointing.

Following the tendency of the engineer to put everything into tabulated form, I have thought it might be interesting to make up a little table which would show at a glance the relative importance of power and speed in a cotton mill, as matters of economy of production. For convenience, I will take for all calculations in this paper the print cloth mill, because of its simplicity and uniformity of product. For the unit of comparison I have used the spindle rather than the pound of product, because the cost of operating a given number of spindles does not vary materially for different numbers of yarn,

whereas the cost per pound does vary considerably, and is therefore not a good unit of comparison. I have assumed a uniform rate of wages for old and new mills, and the same cost of power per horse-power (although of course both have changed considerably), and also the same first cost of machinery and steam-plant, so as to simplify the comparison. For first cost I have taken mules at $3.00 per spindle, with all their appurtenances, shafting, belting and floor space; frames at $3.60 per spindle; steam-plant at $40 per horse-power for the plant itself, and at $50 including foundations, settings, chimney, buildings, etc. I have taken interest at 5 per cent., depreciation on machinery at 7.5 per cent., and on buildings at 4 per cent. Cost of a horse-power with compound engines, $10 a year for fuel and $19 a year for total cost. I do not pretend that these figures are ideal or absolutely accurate. They of course will vary in different mills, but I think they are fair, and any reasonable variations that can be made in them will not materially affect the point the table is intended to illustrate.

COST PER YEAR OF OPERATING ONE SPINDLE ON PRINT CLOTH NUMBERS.

	A.	B.	C.	D.	E.	F.
	Power.	Labor.	Interest and Depreciation.	Totals.	Production.	Resultant Cost per 100 Pounds.
	Cents.	Cents.	Cents.		Pounds.	
Mules, slow speed (1869), .	9½	64	34	$1 07	39	$2 75
Modern mules, high speed,	11 to 16	64	34	1 09 to $1 14	46	
Warp frames, old, 6,000 revolutions, ...	24	58	44	1 26	46	
Sawyer frames, 7,500 revolutions, ...	17	58	44	1 19	56	
Modern frames, 9,200 revolutions, ...	24	59	44	1 27	60	

Supplies not included, except fuel for power.

Comparing high-speed mules with slow, the cost for power is from 16 to 70 per cent. more for the high speed, and yet the total cost of production is 10 to 13 per cent. less. Even with 70 per cent. more power per spindle, the high speed saves 10 per cent. in cost. Taking the old slow-speed warp frames and the modern high-speed spindles, the power per spindle is about the same, and the saving in total cost about 32 per cent. And, comparing the high-speed spindles with Sawyer, at 7,500 revolutions, the power costs 41 per cent. more for the former, but the net saving is 13 per cent.

The old slow-speed mules and frames are of course now nothing but reminiscences. But it is not such a very great while ago that 7,500 was considered high speed for warp spindles. The above table will show easily that a mill to-day cannot afford to run spindles at that speed in competition with modern spindles at 9,200 revolutions, even if it could have a free gift of all the fuel required to drive them. Thus the allowance in the table for fuel for power to drive the spindles at 7,500 revolutions is 9 cents per spindle per year. If this is wiped out, it leaves the total cost of production $1.10 per spindle per year, and $1.96 per 100 pounds of yarn, or over 6 per cent. more than the cost with high speed. Even if we deduct *all* the expenses of the steam power (17 cents per spindle per year), it would still leave the total cost $1.02 per spindle and the cost of product $1.82 per 100 pounds, against $1.84 with high speed. In other words, the free gift of a modern steam-plant large enough to run the slower spindles, and also of all the fuel and labor and expenses of all kinds to operate it, would barely enable them to compete in cost of production with the high-speed spindles, the latter being charged with the cost and all expenses of a steam-plant 41 per cent. larger, and consuming 41 per cent. more fuel than the slow ones. And this is not all. For, when the profits of business are taken into account, the high-speed spindles, with their increased product, would easily leave the slow ones "out of sight" even under the above disadvantages in regard to power.

If it should be thought that the item of depreciation ought to have been made larger for the high-speed spindles than for the slow ones, there is ample margin for this item to be modified to suit any reasonable opinions in this regard, without materially affecting the point of comparison which is the object of the table. The item of profits of business, if taken into the account, would offset any possible modifications of this sort several times over in favor of the high speed. Besides, the item of depreciation is intended to cover the cost of the continual changes and improvements being made in machinery, involving sometimes the discarding of the machines entire, and this item is more than half of the whole amount I have allowed; so that the percentage of increase on account of wear and tear simply would be so small that I did not consider it worth while to calculate it for the purposes of this comparison.

A word in regard to the variation of 5 cents per spindle in the table, in the cost of power for modern mules. The existence of this variation is well known, and of course this difference in cost of power cannot be ignored, providing other things are equal, — quality of work, repairs, waste, wear and tear, etc., — as it then represents a positive and considerable loss, without any compensating advantages. But, if it were a question of cost of power only, as between a slow and a high speed mule, *other things being equal*, the results of a comparison would be the same as with frames, only to less marked extent. The high speed would leave the slow ones "out of sight" as to economy of manufacturing.

Taking now a general view of the entire mill, a comparison between the old and modern mills is no less striking. Going back to the time when both warp and filling were spun on mules (1869), my data show that what was then a good average mill of 44,000 spindles, all mules, was producing 37,700 pounds per week, and required 677 horse-power to drive it, — a product of .85 pounds per spindle per week and of 55 pounds per horse-power per week.

Another, with 28,000 spindles, all mules, produced 24,300 pounds per week, with 430 horse-power; or .87 pounds per spindle per week and 56 pounds per horse-power.

Another mill (1874), with old ring warp and mule filling, with 90,000 spindles, produced 78,000 pounds per week, and required 1,583 horse-power to drive it, — a product of .87 pounds per spindle per week and of 49 pounds per horse-power per week. These were all on print cloth numbers.

A mill with Sawyer warp spinning and fairly high-speed mules produced .93 pounds of cloth per spindle per week, and 1 horse-power produced 46.5 pounds of cloth.

And to-day a modern mill with all frames, at high speed, produces 1.17 pounds per spindle per week, and 1 horse-power produces 46.75 pounds. In round numbers, the product of a 30,000-spindle modern mill is equal to that of a 40,000-spindle mill of twenty years ago.

From these figures we find that the Sawyer warp mill required 19 per cent. more power to turn off a pound of cloth than the old all-mule mills. But this fact did not weigh a feather against the adoption of Sawyer spindles.

Since that period the product per horse-power has not changed materially. But the improvements made in steam-plants meantime have reduced the actual cost of the power per pound of cloth, so that it is less than it was in the old slow-speed "all-mule" mill, the total cost of fuel for power alone being now about .41 cents per pound of cloth, while then it was .66 cents (taking the same price of coal in both).

The deduction to be made from the above table is, that, in regard to cost of production alone, any increase of speed and product will be in the line of economy, so far as cost of power is concerned, even if the latter should increase four times as fast as the production. And this is so unlikely a supposition that practically the question of power is not to be considered for a moment as against speed.

One of the items of power in a cotton mill, and not a small

one, is the friction load of the shafting. Power expended for this is in a sense wasted. It produces nothing and costs a great deal. In the best mills it will be not less than 22 per cent. and often 25 per cent. of the total power. (This includes the friction due to the belts on the loose pulleys of all the machines, as this is the usual method of weighing this load, so that it does not of course represent the mere friction due to weight of the shafting.) In a mill requiring 1,000 horse-power, therefore, 220 to 250 horse-power will be expended in this manner, costing, at $19 per horse-power per year, about $4,200. Various methods have been tried from time to time to reduce this loss. One way has been by reducing the diameter of shafting, sometimes to extremes, and increasing the speed; but not much has been accomplished in results. The percentage remains about the same. In the course of my work I have had occasion to test the power of a large number of mills of all descriptions, old and new, large and small, with excessively heavy and excessively light shafting, at extreme slow and high speeds, and medium heavy at medium speeds, and with all sorts of bearings, and in all sorts of conditions. I have found the friction load to run from 22 up to 39 per cent. The lowest I have ever found was 21.25 per cent., and this was in a very old mill, requiring 1,055 horse-power, with rather heavy shafting, but all at slow speeds, from 210 to 250 revolutions. The friction load was 224 horse-power. I have never found this result equalled in a modern mill. Several years ago I tested two mills in the same yard: one a very old one, with extremely, even ridiculously, heavy shafting, but at very slow speeds; and the other a new mill just completed at that time, with very light shafting at high speeds, and with bearings about 5 feet apart. I remember that I expected to find the friction of the older mill so much more than the new one that it would pay to change the shafting. The test showed so little difference between the two that it was not worth considering. This result was a surprise to me at that time, but would not be so now.

So far as the *theory* of friction is concerned, the laws that govern the driving capacity of a shaft and its friction are so related to each other that it makes no difference in theory whether a large shaft at a slow speed or a small one at a higher speed is used to convey a given amount of power, if the speed in both cases is in inverse ratio to the cubes of their diameters. But in a cotton mill this theory will not hold in practice. Increasing speed of the shafting is liable to increase the friction, and for obvious reasons. The friction of shafting in cotton mills is not due entirely to its dead weight, but more to the lateral stress of the multitude of belts on machines and counters. This stress is independent of the weight of the shaft and has no relation to it, and reducing its diameter will not affect it. On the other hand, when we reduce the diameter and increase the speed to give the same power, we decrease its circumference or rubbing surface only as the diameter, while we increase its speed inversely as its cube. Therefore we have increased the surface velocity in the bearings inversely as the square of the diameter. And, although the weight of the shaft is also reduced in the same ratio, yet the lateral stress of the belts is put upon the rubbing surfaces at the above greatly increased velocity. The friction therefore *ought* to be more, and I am satisfied that it is, other things being equal. Then, when in addition to this the number of bearings is increased, in order to properly support the reduced shaft, we magnify this evil; for in a cotton mill, with bearings suspended from wooden beams and floors, the conditions are far from that perfection which admits of the strict application of any mechanical formulas. Every unnecessary bearing increases the chances for greater friction. In lines which are merely carriers of power, with no pulleys or belts upon them, the above objections to high speed do not apply so forcibly up to a certain point. The fact is, in this as in all other mechanical constructions, it is impossible to apply any strict formulas. They must be materially modified by the carefully noted results of experience.

In the mill where I found the friction 39 per cent. the shafting was rather heavy, but not extremely so. I attributed the excessive friction here to the multiplicity of bearings, and all of a very bad construction, the boxes being absolutely rigid. Of course the difference between 39 per cent. and 22 per cent. is worth saving. It would represent 170 horse-power on a mill requiring 1,000 horse-power, and this would represent a needless loss of $1,700 a year for fuel alone, in the best steam mill. And, more than this, in some cases of partly water and partly steam power mills it may mean the still larger losses from stoppage of machinery or loss of speed, which might be overcome merely by reducing the friction down to a reasonable point. This was, in fact, exactly the case in the mill in question, which I tested recently on account of this condition of things.

High speed of shafting in carding and weaving rooms is especially to be avoided. I have in mind a large mill in which the shafting in these rooms runs over 320 revolutions. The loom pulleys are 5 to 6 inches diameter, the belts very tight; of course the shafting is very small, with bearings every 5 feet, and in one room with 384 looms there are over 500 bearings, whereas half that number with a proper arrangement would have sufficed. Every one of these 250 unnecessary bearings means more or less unnecessary friction.

In yarn mills the friction is of course less than in weaving mills. I have found it about 18 to 19 per cent.

The suggestion that has been made by electricians to overcome this waste of power in friction by attaching motors to each line will evidently not accomplish the purpose. The shafting and machine belts will still remain, besides having the loss from the conversion of power, — about 15 per cent. in the present state of the art.

Carrying steam to a number of small engines distributed about the mill was once suggested, I believe, in a certain mill, but of course is not to be thought of. At present the only thing to do is to avoid extreme speed, use bearings of good

construction and in as small number as possible, and by a good arrangement keep the friction down to as low a point as possible.

Although in this paper I have emphasized the supreme importance of high speed of spindles and the reliability of the motive power, rather than a fine economy of fuel, yet it of course goes without saying that this economy is to be sought also by every practicable method; and all improvements in steam engineering to this end are to be welcomed, so long as they do not raise any question as to the more vital point in cotton manufacturing, — certainty of continuous operation.

(No. 52.)

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O. S. Brown	Salmon Falls Manuf. Co.	Salmon Falls, N. H.
S. N. Brown	Contoocook Manuf. Co.	Penacook, N. H.
E. C. Bucklin	Interlaken Mills	Providence, R. I.
Edward N. Burke		Lowell, Mass.
W. R. Burnham	Uncasville Manuf. Co.	Norwich, Conn.

William D. Cadwell	Jackson Co.	Nashua, N. H.
Byron F. Card	New Bedford Manuf. Co.	New Bedford, Mass.
George A. Chace	Bourne Mills	Fall River, Mass.
Simeon B. Chase	King Philip Mills	Fall River, Mass
George A. Clark	Manchester Mills	Manchester, N. H.
Jeremiah Clark		Lowell, Mass.
Alfred Clarke		Lowell, Mass.
F. E. Clarke	Pemberton Co.	Lawrence, Mass.
Alonzo A. Coburn		Lowell, Mass.
J. G. Coburn		Newton, Mass.
John A. Collins	American Linen Co.	Fall River, Mass.
J. Andrew Comstock	Uncasville Manuf. Co.	Uncasville, Conn.
Frank B. Comins		Providence, R. I.
J. J. Connell	Cohannet Mills	Taunton, Mass.
A. S. Covel	Tremont and Suffolk Mills	Boston, Mass.
A. G. Cumnock	Boot Cotton Mills	Lowell, Mass.
Andrew J. Currier	Albion Mills.	Albion, R. I.
Woodbury K. Dana	Banner Mill	Saccarappa, Me.
A. W. Danforth	Shanghai Cot. Cl'h Mill Co.	Shanghai, China.
John W. Danielson	Quinebaug Co.	Providence, R. I.
B. D. Davol		Fall River, Mass.
James Dempsey	Lewiston Bleachery	Lewiston, Me.
William P. Dempsey	Dempsey Bleachery	Pawtucket, R. I.
Charles W. Dennett	Westbrook Manuf. Co.	Saccarappa, Me.
Charles A. Denny		Leicester, Mass.
George Dexter	Pepperell & Laconia Cos.	Boston, Mass.
Eben S. Draper		Hopedale, Mass.
George A. Draper		Hopedale, Mass.
William F. Draper		Hopedale, Mass.
William F. Draper, Jr.		Hopedale, Mass.
Joseph Dronsfield	Fletcher Manuf. Co.	Providence, R. I.
David H. Dyer	Quequechan Mills	Fall River, Mass.
Isaac Eaton		Nashua, N. H.
R. W. Eaton	Cabot Manuf. Co.	Brunswick, Me.
John Eccles	Ponemah Mills	Taftville, Conn.
Lawrence V. Elder	Galveston C. & W. Mills	Galveston, Tex.
Frederick W. Ely	Falls Co.	Norwich, Conn.
Herbert R. Farnum	Bernon Manuf. Co.	Georgiaville, R. I.
William Firth		Boston, Mass.
Charles H. Fish	P. C. Cheney Co.	Manchester, N. H.
Herbert Fisher		Taunton, Mass.
Frederick A. Flather		Newton Upper Falls, Mass
M. F. Foster	Denison Cotton Manuf. Co.	Denison, Tex.
Philip H. Fowler	Gloucester Gingham Mills	Gloucester, N. J.
C. S. Frisbie	Attawaugan Mills	Attawaugan, Conn.

William Gammell	Berkeley Co.	Providence, R. I.
A. J. Gardiner	Danielsonville Cotton Co.	Danielsonville, Conn.
James G. Garland		Biddeford, Me.
Richard Garsed	Wingohocking Mills	Philadelphia, Penn.
James A. Gary	Alberton Cotton Mills	Baltimore, Md.
John Gegenheimer	Boston Duck Co.	Bondsville, Mass.
Charles E. Getchell	Boston Duck Co.	Bondsville, Mass.
William C. Godfrey	Indian Orchard Mills	Indian Orchard, Mass.
Alfred M. Goodale	Boston Manuf. Co.	Waltham, Mass.
Charles J. Goodwin	Indian Orchard Mills	Indian Orchard, Mass.
David Gowdey		Providence, R. I.
William B. Gowdey		Providence, R. I.
Stephen Greene		Boston, Mass.
William C. Greene	Columbian Manuf. Co.	Greenville, N. H.
Frederick Grinnell		Providence, R. I.
Arthur H. Gulliver	Lonsdale Co.	Ashton, R. I.
Frank R. Hadley	Bennett Manuf. Co.	New Bedford, Mass.
Frank J. Hale		Newton Upper Falls, Mass.
Samuel Hale	Portsmouth Co.	South Berwick, Me.
William E. Hall	Lawrence Manuf. Co.	Lowell, Mass.
Z. D. Hall	Berkshire Cotton Manuf. Co.	Adams, Mass.
John F. Hamlet	Manchaug Co.	Manchaug, Mass.
J. O. Hannum	Victory Mills	Saratoga, N. Y.
C. M. Harris, Jr.	Oakdale Shirt Manuf. Co.	Oakdale, Mass.
Frank Harris	Hamlet Mills	Woonsocket, R. I.
Henry F. Harris	West Boylston Manuf. Co.	Worcester, Mass.
Frank Haskell	Westbrook Manuf. Co.	Saccarappa, Me.
William Hayes	Barker Mill	Auburn, Me.
James G. Hill	Lawrence Manuf. Co.	Lowell, Mass.
Charles H. Hobbs	Slatersville Manuf. Co.	Slatersville, R. I.
John Holland	Cocheco Manuf. Co.	Dover, N. H.
Stephen Holman		Worcester, Mass.
Gideon F. Holmes	Plymouth Cordage Co.	No. Plymouth, Mass.
George W. Holt, Jr.	Monohansett Manuf. Co.	Putnam, Conn.
William Hooper	Atlantic Cotton Mills	Boston, Mass.
John Hopkinson	Mississippi Mills	Wesson, Miss.
Elisha H. Howard	Harris Manuf. Co.	Providence, R. I.
Henry S. Howe		Boston, Mass.
W. S. Hume	Danielsonville Cotton Mills	Danielsonville, [illegible]
David L. Jewell	China, Webs'r & Pemb'ke M.	Suncook, N. H.
William C. Jillson	Hop River Manuf. Co.	Willimantic, [illegible]
D. W. Johnson	Monadnock Mills	Claremont, [illegible]
D. J. Johnston	Harmony Mills	Cohoes, N. Y.
David S. Johnston	Harmony Mills	Cohoes, N. Y.
Roland R. Kelley		Lowell, Mass.
Joseph H. Kendrick		Providence [illegible]

George E. Kent	Pittsfield Mills	Pittsfield, N. H.
Hervey Kent,	Exeter Manuf. Co.	Exeter, N. H.
William J. Kent	Grinnell Manuf. Co.	New Bedford, Mass.
John Kilburn	Lawrence Manuf. Co.	Lowell, Mass.
John M. Kimball	Westbrook Manuf. Co.,	Westbrook, Me.
J. H. A. Klauder		Philadelphia, Penn.
Albert F. Knight	Amory Manuf. Co.	Manchester, N. H.
Walter B. Knight	Bozrahville Manuf. Co.	Bozrahville, Conn.
Harold Lawton	Merchants' Manuf. Co.	Montreal, Canada.
Evan Arthur Leigh		Boston, Mass.
Charles W. Lippitt	Social Manuf. Co.	Providence, R. I.
Henry F. Lippitt	Globe Mill	Providence, R. I.
Robert W. Lord		Kennebunk, Me.
Charles L. Lovering	Mass. Cotton Mills	Boston, Mass.
Ernest Lovering	Lyman Mills	Holyoke, Mass.
Henry M. Lovering	Whittenton Manuf. Co.	Taunton, Mass.
Arthur H. Lowe		Fitchburg, Mass.
J. S. Ludlam	Merrimack Manuf. Co.	Lowell, Mass.
Alvin S. Lyon	Lowell Manuf. Co.	Lowell, Mass.
Charles T. Main		Providence, R. I.
Charles R. Makepeace		Providence, R. I.
Charles H. Manning	Amoskeag Manuf. Co.	Manchester, N. H.
Henry F. Mansfield	Mohawk Valley Mills	Utica, N. Y.
Albert G. Martin	Eufaula Cotton Mills	Eufaula, Ala.
Rufus A. Maxfield		Lowell, Mass.
Thomas Mayor		Providence, R. I.
Robert McArthur	Pepperell & Laconia Cos.	Biddeford, Me.
Charles D. McDuffie	Manchester Mills	Manchester, N. H.
Fred. C. McDuffie	Everett Mills	Lawrence, Mass.
William E. McGill		Philadelphia, Penn.
William G. McLoon	Boston Manuf. Co.	Waltham, Mass.
James H. McMullan		Biddeford, Me.
John Tempest Meats		Taunton, Mass.
Timothy Merrick	Merrick Thread Co.	Holyoke, Mass.
Frank M. Messenger	Grosvenor Dale Co.	North Grosvenor Dale, Conn.
George F. Morgan	Tremont & Suffolk Mills	Lowell, Mass.
Albert H. Morton		Lowell, Mass.
Oliver H. Moulton	Hamilton Manuf Co.	Lowell, Mass.
Frank J. Muir	Tremont & Suffolk Mills	Lowell, Mass.
Franklin Nourse	York Manuf. Co.	Saco, Me.
E. H. Nutting	Hooksett Manuf. Co.	Hooksett, N. H.
Warren M. Orswell	Shirley Yarn Co.	Fitchburg, Mass.
Elmer E. Page	Shetucket Co.	Norwich, Conn.
Francis J. Parker	Monadnock Mills	Boston, Mass.
Walter E. Parker	Pacific Mills	Lawrence, Mass.

John H. Parks	New Brunsw'k Cotton Mills	St. John, N. B.
William D. Pennell	Hill Manuf. Co.	Lewiston, Me.
Haven C. Perham		Lowell, Mass.
John M. Pevey		Lowell, Mass.
Moses Pierce	Norwich Bleachery	Norwich, Conn.
Charles H. Plummer	Great Falls Manuf. Co.	Great Falls, N. H.
Thomas C. Powell		Providence, R. I.
H. L. Pratt	Bates Manuf. Co.	Lewiston, Me.
Thomas Pray, Jr.	193 "Times" Building	New York City, N. Y.
J. E. Prest		Whitinsville, Mass.
A. M. Pulsifer	Barker Mill	Auburn, Me.
M. W. Quinn	Hamilton Woolen Co.	Amesbury, Mass.
T. G. Ramsdell	Monument Mills	Housatonic, Mass.
Robert Redford	Arlington Mills	Lawrence, Mass.
James Renfrew, Jr.	Renfrew Manuf. Co.	Adams, Mass.
Roscoe C. Reynolds		Lewiston, Me.
F. H. Rice	Holbrook Mills	W. Boylston, Mass.
Charles E. Riley		Boston, Mass.
John K. Russell	Grosvenor Dale Co.	Grosvenor Dale, Conn.
H. Saltonstall	Pacific Mills	Boston, Mass.
Arnold B. Sanford	Globe Yarn Mill	Fall River, Mass.
J. H. Sawyer	Newmarket Manuf. Co.	Boston, Mass.
G. H. Sayward	Standard Yarn Co.	Oswego, N. Y.
John Scott	Willimantic Linen Co.	Willimantic, Conn.
Thomas C. Sheldon	Sawyer Mill	Boylston, Mass.
George E. Sherman	Valley Falls Co.	Valley Falls, R. I.
William F. Sherman	Atlantic Cotton Mills	Lawrence, Mass.
Charles M. Shove	Granite Mills	Fall River, Mass.
Francis H. Silsbee	Pacific Mills	Lawrence, Mass.
Arba C. Slater	Linwood Mills	Whitinsville, Mass.
Robert R. Smith	Greenwoods Co.	New Hartford, Conn.
Wm. S. Southworth	Mass. Cotton Mills	Lowell, Mass.
William I. Spear	Jackson Co.	Nashua, N. H.
S. S. Spencer	Conestoga Steam Mills	Lancaster, Penn.
Geo. R. Stearns	Riverside Mills	Augusta, Ga.
Joseph Stone	85 Milk Street	Boston, Mass.
Herman F. Straw	Amoskeag Manuf. Co.	Manchester, [illegible]
James O. Sweet	Ashland Cotton Co.	Jewett City [illegible]
Edward P. Taft	Ponemah Mills	[illegible]
George P. Taylor	Lancaster Mills	[illegible]
Richard Thackeray	Weetamoe Mills	[illegible]
Earl A. Thissell		[illegible]
Ariel C. Thomas	Clinton Manuf. Co.	[illegible]
Charles E. Thomas	Globe Mill	[illegible]

E. W. Thomas . . .	Tremont and Suffolk Mills .	Lowell, Mass.
D. M. Thompson . .	Mills of B. B. & R. Knight	Providence, R. I.
Samuel J. Thompson .	Valatie Cotton Mills . . .	Valatie, N. Y.
Osmon B. Tilton . .	Lynchburg Cotton Mills .	Lynchburg, Va.
James P. Tolman . .	Samson Cordage Works .	Boston, Mass.
William E. Trainer . .	Linwood Mills	Linwood Sta., Penn.
Edmund E. Truesdell .	China, Webs'r & Pemb'ke M.	Suncook, N. H.
H. E. Walmesley . .	Clark Thread Co.	Newark, N. J.
James Waring . . .	Narragansett Mills . . .	Fall River, Mass.
John Waterman . . .	Warren Manuf. Co. . . .	Warren, R. I.
J. W. Wattles . . .	. . . . .	Canton, Mass.
T. B. Wattles . . .	Boscawen Mills	Penacook, N. H.
George W. Weeks . .	Lancaster Mills	Clinton, Mass.
John Walter Wells . .	Millville Manuf. Co. . . .	Woodbury, N. J.
Henry F. West . . .	. . . . .	Gloucester, N. J.
Channing Whitaker	. . . . .	Tyngsborough, Mass.
A. Tenny White . . .	Manville Co.	Manville, R. I.
Harry T. Whitin . .	Rockdale Mill	Northbridge, Mass.
William H. Whitin . .	Whitin Manuf. Co. . . .	Whitinsville, Mass.
A. N. Whiting . . .	L. M. Harris Manuf. Co. .	Oakdale, Mass.
William S. Whitney	. . . . .	Fall River, Mass.
E. B. Wilbur	Pequot Mills	Montville, Conn.
Henry M. Wilcox . .	John Rhodes Warp Mill .	Millbury, Mass.
Theop. W. Wilmarth .	Overland Cotton Mills Co. .	Denver, Col.
Thomas Wilmarth . .	Saunders Cotton Mills . .	Saundersville, Mass.
A. S. Winslow . . .	Crompton Co.	Crompton, R. I.
George Wood . . .	Millville Manuf. Co. . . .	Philadelphia, Penn.
C. J. H. Woodbury .	. . . . .	Boston, Mass.
Daniel Wright . . .	. . . . .	Adams, Mass.

Total number of Honorary Members 2
Total number of Active Members 242

MEMBERS OF THE ASSOCIATION.

1892.

ARRANGED BY STATES.

MAINE.

Stephen I. Abbot	Lockwood Co.	Waterville.
A. D. Barker	Avon Manuf. Co.	Lewiston.
George W. Bean	Androscoggin Mills	Lewiston.
Woodbury K. Dana	Banner Mill	Saccarappa.
James Dempsey	Lewiston Bleachery	Lewiston.
Charles W. Dennett	Westbrook Manuf. Co.	Saccarappa.
R. W. Eaton	Cabot Manuf. Co.	Brunswick.
James G. Garland		Biddeford.
Samuel Hale	Portsmouth Co.	South Berwick.
Frank Haskell	Westbrook Manuf. Co.	Saccarappa.
William Hayes	Barker Mill	Auburn.
John M. Kimball	Westbrook Manuf. Co.	Westbrook.
Robert W. Lord		Kennebunk.
Robert McArthur	Pepperell & Laconia Cos.	Biddeford.
James H. McMullan		Biddeford.
Franklin Nourse	York Manuf. Co.	Saco.
William D. Pennell	Hill Manuf. Co.	Lewiston.
H. L. Pratt	Bates Manuf. Co.	Lewiston.
A. M. Pulsifer	Barker Mill	Auburn.
Roscoe C. Reynolds		Lewiston.

NEW HAMPSHIRE.

Stephen N. Bourne	Stark Mills	Manchester.
O. S. Brown	Salmon Falls Manuf. Co.	Salmon Falls.
S. N. Brown	Contoocook Manuf. Co.	Penacook.
William D. Cadwell	Jackson Co.	Nashua.
George A. Clark	Manchester Mills	Manchester.
Isaac Eaton		Nashua.
Charles H. Fish	P. C. Cheney Co.	Manchester.
William C. Greene	Columbian Manuf. Co.	Greenville.

John Holland	Cocheco Manuf. Co.	Dover.
David L. Jewell	China, Webs'r & Pemb'ke M.	Suncook.
D. W. Johnson	Monadnock Mills	Claremont.
George E. Kent	Pittsfield Mills	Pittsfield.
Hervey Kent	Exeter Manuf. Co.	Exeter.
Albert F. Knight	Amory Manuf. Co.	Manchester.
Charles H. Manning	Amoskeag Manuf. Co.	Manchester.
Charles D. McDuffie	Manchester Mills	Manchester.
E. H. Nutting	Hooksett Manuf. Co.	Hooksett.
Charles H. Plummer	Great Falls Manuf. Co.	Great Falls.
William I. Spear	Jackson Co.	Nashua.
Herman F. Straw	Amoskeag Manuf. Co.	Manchester.
Edmund E. Truesdell	China, Webs'r & Pemb'ke M.	Suncook.
T. B. Wattles	Boscawen Mills	Penacook.

MASSACHUSETTS.

Honorary Member.

Benjamin F. Nourse		Boston.

Active Members.

Alfred E. Adams	Whitinsville Cotton Mills	Whitinsville.
Edward Atkinson		Boston.
Edward W. Atkinson		Boston.
Edwin H. Baker	Otis Co.	Ware.
W. A. Barrell	Lawrence Duck Co.	Lawrence.
Lewis C. Bass		Boston.
Edwin N. Bartlett	Sigourney Mill	North Oxford.
John Birkenhead		Mansfield.
Nathaniel B. Borden	Barnard Manuf. Co.	Fall River.
Richard B. Borden	Troy C. & W. Manuf. Co.	Fall River.
Thomas J. Borden	American Print Works	Fall River.
Thomas S. Borden	Metacomet Mills	Fall River.
B. C. Brainard		South Hadley Falls.
Edward A. Brigham		Boston.
Edward N. Burke		Lowell.
Byron F. Card	New Bedford Manuf. Co.	New Bedford.
George A. Chace	Bourne Mills	Fall River.
Simeon B. Chase	King Philip Mills	Fall River.
Jeremiah Clark		Lowell.
Alfred Clarke		Lowell.
F. E. Clarke		Lawrence.
Alonzo A. Coburn		Lowell.
J. G. Coburn		Newton.
John A. Collins	American Linen Co.	Fall River.
J. J. Connell	Cohannet Mills	Taunton.
Alphonso S. Covel	Tremont & Suffolk Mills	Boston.
A. G. Cumnock	Boott Cotton Mills	Lowell.

B. D. Davol		Fall River.
Charles A. Denny		Leicester.
George Dexter	Pepperell & Laconia Cos.	Boston.
Eben S. Draper		Hopedale.
George A. Draper		Hopedale.
William F. Draper		Hopedale.
William F. Draper, Jr.		Hopedale.
David H. Dyer	Quequechan Mills	Fall River.
William Firth		Boston.
Herbert Fisher		Taunton.
Frederick A. Flather		Newton Upper Falls.
John Gegenheimer	Boston Duck Co.	Bondsville.
Charles E. Getchell	Boston Duck Co.	Bondsville.
William C. Godfrey	Indian Orchard Mills	Indian Orchard.
Alfred M. Goodale	Boston Manuf. Co.	Waltham.
Charles J. Goodwin	Indian Orchard Mills	Indian Orchard.
Stephen Greene		Boston.
Frank R. Hadley	Bennett Manuf. Co.	New Bedford.
Frank J. Hale		Newton Upper Falls.
William E. Hall	Lawrence Manuf. Co.	Lowell.
Z D. Hall	Berkshire Cotton Manuf. Co.	Adams.
C. M. Harris, Jr.	Oakdale Shirt Manuf. Co.	Oakdale.
Henry F. Harris	West Boylston Manuf. Co.	Worcester.
James G. Hill	Lawrence Manuf. Co.	Lowell.
Stephen Holman		Worcester.
Gideon F. Holmes	Plymouth Cordage Co.	North Plymouth.
William Hooper		Boston.
Henry S. Howe		Boston.
Roland R. Kelley		Lowell.
William J. Kent	Grinnell Manuf. Co.	New Bedford.
John Kilburn	Lawrence Manuf. Co.	Lowell.
Evan Arthur Leigh		Boston.
Chas. L. Lovering	Mass. Cotton Mills	Boston.
Ernest Lovering	Lyman Mills	Holyoke.
Henry M. Lovering	Whittenton Mills	Taunton.
Arthur H. Lowe		Fitchburg.
J. S. Ludlam	Merrimack Manuf. Co.	Lowell.
Alvin S. Lyon	Lowell Manuf. Co.	Lowell.
Rufus A. Maxfield		Lowell.
Fred. C. McDuffie	Everett Mills	Lawrence.
William G. McLoon	Boston Manuf. Co.	Waltham.
John Tempest Meats		Taunton.
Timothy Merrick	Merrick Thread Co.	[illegible]lyoke.
George F. Morgan	Tremont & Suffolk Mills	[illegible]well.
Albert H. Morton		[illegible]well.
Oliver H. Moulton	Hamilton Manuf. Co.	[illegible]well.
Frank J. Muir	Tremont & Suffolk Mills	[illegible]well.
Warren M. Orswell	[illegible] Yarn Co.	[illegible]tchburg.

Francis J. Parker	Monadnock Mills	Boston.
Walter E. Parker	Pacific Mills	Lawrence.
Haven C. Perham		Lowell.
John M. Pevey		Lowell.
J. E. Prest		Whitinsville.
M. W. Quinn	Hamilton Woollen Co.	Amesbury.
T. G. Ramsdell	Monument Mills	Housatonic.
Robert Redford	Arlington Mills	Lawrence.
James Renfrew, Jr.	Renfrew Manuf. Co.	Adams.
F. H. Rice	Holbrook Mills	West Boylston.
Charles E. Riley		Boston.
Henry Saltonstall	Pacific Mills	Boston.
Arnold B. Sanford	Globe Yarn Mill	Fall River.
J. H. Sawyer	Newmarket Manuf. Co.	Boston.
Thomas C. Sheldon	Sawyer Mill	Boylston.
William F. Sherman	Atlantic Cotton Mills	Lawrence.
Charles M. Shove	Granite Mills	Fall River.
Francis H. Silsbee	Pacific Mills	Lawrence.
Arba C. Stater	Linwood Mills	Whitinsville.
William S. Southworth	Mass. Cotton Mills	Lowell.
Joseph Stone		Boston.
Geo. P. Taylor	Lancaster Mills	Clinton.
Richard Thackeray	Weetamoe Mills	Fall River.
Earl A. Thissell		Florence.
E. W. Thomas	Tremont & Suffolk Mills	Lawrence.
James P. Tolman	Samson Cordage Works	Boston.
James Waring	Narragansett Mills	Fall River.
J. W. Wattles		Canton.
George W. Weeks	Lancaster Mills	Clinton.
Channing Whitaker		Tyngsborough.
Harry T. Whitin	Rockdale Mill	Northbridge.
William H. Whitin	Whitin Manuf. Co.	Whitinsville.
A. N. Whiting	L. M. Harris Manuf. Co.	Oakdale.
William S. Whitney		Fall River.
Henry M. Wilcox	John Rhodes Warp Mill	Millbury.
Thomas Wilmarth	Saunders Cotton Mills	Saundersville.
C. J. H. Woodbury		Boston.
Daniel Wright		Adams.

RHODE ISLAND.

Charles T. Aldrich	Baltic Mills	Providence.
William Ames	Fletcher Manuf. Co.	Providence.
Abel T. Atherton		Pawtucket.
Truman Beckwith	Dyerville Manuf. Co.	Providence.
E. C. Bucklin	Interlaken Mills	Providence.
Frank B. Comins		Providence.
Andrew J. Currier	Albion Mills	Providence.
John W. Danielson	Quinebaug Co.	Providence.

William P. Dempsey	Dempsey Bleachery	Pawtucket.
Joseph Dronsfield	Fletcher Manuf. Co.	Providence.
Herbert R. Farnum	Bernon Manuf. Co.	Georgiaville.
William Gammell	Berkeley Co.	Providence.
David Gowdey		Providence.
William B. Gowdey		Providence.
Frederick Grinnell		Providence.
Arthur H. Gulliver	Lonsdale Co.	Ashton.
John F. Hamlet	Manville Co.	Manville.
Frank Harris	Hamlet Mills	Woonsocket.
Charles H. Hobbs	Slatersville Manuf. Co.	Slatersville.
Elisha H. Howard	Harris Manuf. Co.	Providence.
Joseph H. Kendrick		Providence.
Charles W. Lippitt	Social Manuf. Co.	Providence.
Henry F. Lippitt	Globe Mill	Providence.
Charles T. Main		Providence.
Charles R. Makepeace		Providence.
Thomas Mayor		Providence.
Thomas C. Powell		Providence.
George E. Sherman	Valley Falls Co.	Valley Falls.
Edward P. Taft	Ponemah Mills	Providence.
Ariel C. Thomas	Clinton Manuf. Co.	Woonsocket.
Charles E. Thomas	Globe Mill	Woonsocket.
D. M. Thompson	Mills of B. B & R. Knight	Providence.
John Waterman	Warren Manuf. Co.	Warren.
A. Tenny White	Manville Co.	Manville.
A. S. Winslow	Crompton Co.	Crompton.

CONNECTICUT.

Joseph D. Aiken	Williamsville Manuf. Co.	Williamsville.
H. C. Atwood	Williamsville Manuf. Co.	Killingly.
James A. Atwood	Wauregan Manuf. Co.	Wauregan.
E. S. Boss	Willimantic Linen Co.	Willimantic.
W. R. Burnham	Uncasville Manuf. Co.	Norwich.
J. Andrew Comstock	Uncasville Manuf. Co.	Uncasville.
John Eccles	Ponemah Mills	Taftville.
Frederick W. Ely	Falls Co.	Norwich.
C. S. Frisbie	Attawaugan Mills	Attawaugan.
A. J. Gardiner	Danielsonville Cotton Co.	Danielsonville.
George W. Holt, Jr.	Monohansett Manuf. Co.	[illegible]nam.
W. S. Hume	Danielsonville Cotton Co.	[illegible]elsonville.
William C. Jillson	Hop River Manuf. Co.	[illegible]mantic.
Walter B. Knight	Bozrahville Manuf. Co.	[illegible]ahville.
Frank M. Messenger	Grosvenor Dale Co.	[illegible]rosvenor Dale.
Elmer E. Page	Shetucket Co.	[illegible]ich.
Moses Pierce	Norwich Bl[illegible]y	[illegible].
John K. Russell	Grosvenor [illegible]	[illegible]or Dale.

John Scott	Willimantic Linen Co.	Willimantic.
Robert R. Smith	Greenwoods Co.	New Hartford.
James O. Sweet	Ashland Cotton Co.	Jewett City.
E. B. Wilbur	Pequot Mills	Montville.

NEW YORK.

HONORARY MEMBER.

George Arms		New York City.

ACTIVE MEMBERS.

J. O. Hannum	Victory Mills	Saratoga.
David J. Johnston	Harmony Mills	Cohoes.
David S. Johnston	Harmony Mills	Cohoes.
Henry F. Mansfield	Mohawk Valley Mills	Utica.
Thomas Pray, Jr.		New York City.
G. H. Sayward	Standard Yarn Co.	Oswego.
Samuel J. Thompson	Valatie Cotton Mills	Valatie.

NEW JERSEY.

Philip H. Fowler	Gloucester Gingham Mills	Gloucester.
H. E. Walmesley	Clark Thread Co.	Newark.
John Walter Wells	Millville Manuf. Co.	Woodbury.
Henry F. West		Gloucester.

PENNSYLVANIA.

Richard Garsed	Wingohocking Mills	Philadelphia.
J. H. A. Klauder		Philadelphia.
William E. McGill		Philadelphia.
S. S. Spencer	Conestoga Steam Mills	Lancaster.
William E. Trainer	Linwood Mills	Linwood Station.
George Wood	Milville Manuf. Co.	Philadelphia.

DELAWARE.

William P. Bancroft		Wilmington.

MARYLAND.

James A. Gary		Baltimore.

VIRGINIA.

Osmon B. Tilton	Lynchburg Cotton Mills	Lynchburg.

GEORGIA.

George R. Stearns	Riverside Mills	Augusta.

ALABAMA.

Albert G. Martin	Eufaula Cotton Mills	Eufaula.

MISSISSIPPI.

John Hopkinson . . .	Mississippi Mills	Wesson.

TEXAS.

Lawrence V. Elder . .	Galveston C. & W. Mills .	Galveston.
M. F. Foster	Denison Cotton Manuf. Co.	Denison.

COLORADO.

Theop. W. Wilmarth .	Overland Cotton Mills Co.	Denver.

CANADA.

Harold Lawton . . .	Merchants' Manuf. Co. . .	Montreal.

NEW BRUNSWICK.

John H. Parks . . .	New Brunsw'k Cotton Mills	St. John.

ENGLAND.

George Ashworth	Manchester.

CHINA.

A. W. Danforth . . .	Shanghai Cot. Cl'h Mill Co.	Shanghai.

RECAPITULATION.

ACTIVE MEMBERS.

Maine	20
New Hampshire	22
Massachusetts	113
Rhode Island	35
Connecticut	22
New York	7
New Jersey	4
Pennsylvania	6
Delaware	1
Maryland	1
Virginia	1
Georgia	1
Alabama	1
Mississippi	1
Texas	2
Colorado	1
Canada	
New Brunswick	
England	
China	

PRELIMINARY NOTICE, AND CALL FOR MEETING.

NEW ENGLAND COTTON MANUFACTURERS' ASSOCIATION,
53 STATE STREET, ROOM 1043, BOSTON, March 10, 1892.

DEAR SIR: — The Board of Government has initiated a new policy for the Association meeting to be held at the close of next April. It is to dispense with the formal papers heretofore provided, and to limit the proceedings to informal discussion of topical questions by *members only*. To this end they have selected a list of subjects of interest to mill managers; and have, in each case, assigned a member to open briefly the discussion, in order to call out remarks upon it from the members at large. They earnestly hope for your co-operation in the matter; believing that new interest will be aroused by this method, and the meetings made more attractive.

The topics chosen, and the names of the members who will briefly introduce them, are as follows: —

1. The benefits derived from the licker-in and shell-feed system to cotton cards. — Mr. E. W. THOMAS, Lowell, Mass.

2. Is the production of a mill increased or diminished by stopping for Saturday half-holidays? — Mr. F. M. MESSENGER, No. Grosvenor Dale, Conn.

3. What is the best policy to pursue in manufacturing concerns having large quantities of similar machinery; whether to have one overseer over a large amount of work, or to distribute it among two or three overseers? — Mr. CHARLES D. MCDUFFIE, Manchester, N. H.

4. What has been the result of experience in bringing the power from engines or water-wheels into the mill; at the end, or in the centre, in mills of not less than 350 feet in length? — Mr. JOHN KILBURN, Lowell, Mass.

5. The use of single or double boss rolls on spinning frames; from which can be derived the most benefit? — Mr. WILLIAM J. KENT, New Bedford, Mass.

6. Tests of spindle oils. — Mr. A. M. GOODALE, Waltham, Mass.

7. The life of incandescent lamps. — Mr. W. S. SOUTHWORTH, Lowell, Mass.

8. Picking, as applied to the English system of carding. — Mr. ROBERT MCARTHUR, Biddeford, Me.

9. What is the best design for line-shafting, transmitting over fifty horse-power, permitting stopping and starting on any floor, without interfering with the motor or with other shafting? — Mr. STEPHEN GREENE, Boston, Mass.

This preliminary notice is issued by direction of the Board, in order that the members may take part, with more interest, in the discussion.

AMBROSE EASTMAN,
Secretary.

NEW ENGLAND COTTON MANUFACTURERS' ASSOCIATION,
BOSTON, April 11, 1892.

DEAR SIR: — The stated Annual Meeting of the Association will be held at the Massachusetts Institute of Technology, Boylston Street, Boston, on Wednesday, April 27, 1892, at 10 o'clock A.M., for the choice of officers for the ensuing year, and the transaction of other appropriate business.

Upon the conclusion of the business of the meeting the topics announced in the circular issued under date of March 10 ulto., will be taken up in their order; and the Board confidently hopes that the members at large will actively participate in their discussion.

By order of the Board of Government,

AMBROSE EASTMAN,
Secretary.

PROCEEDINGS.

Pursuant to the foregoing notice, the stated annual meeting of the Association was held at the Massachusetts Institute of Technology on Wednesday, April 27, 1892, at 10 o'clock A.M.

The President, Mr. WALTER E. PARKER, occupied the chair. The call for the meeting was read by the Secretary, and also the preliminary notice issued in advance of the regular call for the meeting.

The President then announced that the meeting was open for business; the first item of which was the election of officers for the ensuing year.

On motion of Mr. RICHARD GARSED it was voted that the Chair appoint a committee to nominate officers for the ensuing year. Accordingly the President appointed as that committee Messrs. H. L. PRATT of Lewiston, Me.; CHARLES D. McDUFFIE of Manchester, N. H.; JOHN KILBURN of Lowell, Mass.; RICHARD GARSED of Philadelphia, Pa., and HERBERT FISHER of Taunton, Mass.

The reports of the Secretary, Treasurer and Auditor were then presented: and by vote were accepted, and ordered to be placed on file.

The SECRETARY. At the meeting of the Board of Government, just held, the Secretary was requested to announce a gift to the Association by Mr. E. M. SHAW of Nashua, N. H., of a complete set of Reports of the Association from the beginning; which will be very valuable in the office, for

reference. The Board has passed a vote of thanks to him for his generosity.

The Secretary then read the names of persons who had been recommended by vote of the Board of Government, for election to membership in the Association; as follows: —

Messrs.	TRUMAN BECKWITH,	Providence, R. I.
	ROBERT BURGESS,	South Berwick, Me.
	J. J. CONNELL,	Taunton, Mass.
	JOHN ECCLES,	Taftville, Conn.
	F. J. HALE,	Newton Upper Falls, Mass.
	WILLIAM E. HALL,	Lowell, Mass.
	WILLIAM E. MCGILL,	Philadelphia, Penn.
	WILLIAM G. MCLOON,	Waltham, Mass.
	FRED W. MOORE,	Millbury, Mass.
	FRANK J. MUIR,	Lowell, Mass.
	ELMER E. PAGE,	Norwich, Conn.
	JAMES A. WALSH,	Lewiston, Me.

On motion of Mr. O. S. BROWN these gentlemen were elected as members of the Association.

The PRESIDENT. We will now take up the first topic for discussion, before the committee on nomination return to make their report. If there is no objection, I will call upon Mr. E. W. THOMAS of Lowell to present the first topic for discussion to-day, viz., "The benefits derived from the licker-in and shell-feed system to cotton cards."

Mr. THOMAS. One of the great benefits derived from using the revolving top card is the method of feeding the cotton to the card cylinder, which is peculiar to this class of card, and one adopted by practically all builders of the card to-day.

The figures to be presented are from the results obtained by the adoption of this kind of feed to the Foss & Pevey and the Whitehead & Atherton patterns of cards, and figures can and probably will be presented showing the benefit derived by its adoption on the common American thirty-six-inch card.

In the fall of 1890, the management of the Tremont & Suffolk Mills, in considering what improvements could be made in the carding department in the Suffolk Mills, which consisted

of 280 Foss & Pevey cards in one room and on the same grade of work, resolved to experiment with the shell-feed and saw-tooth lickers-in. A section of ten cards was changed, and the results obtained were so highly satisfactory that the balance of the cards was speedily changed. The work of changing these cards was intrusted to the Lowell Machine Shop, who originally built the cards some eight years before.

The speed of the cylinders was increased from 142 to 160 revolutions per minute. Fillet clothing, on cylinders, was put onto many of the cards at the time the feed changes were being applied.

These cards had been used for carding cotton for warp yarns from 20's to 30's at the rate of about 60 pounds per day, but for the few months just preceding the changes referred to they had been working at the rate of 72 pounds per day. After the changes were finished the cards were made to do 85 pounds per day, at which rate they are running to-day. We had not up to the time the changes were made been extremely well pleased with the working of the card, having had more or less trouble with droppings from the end of the doffer, split laps and a not perfect sliver.

Our advantages gained by the changes are a larger production by 15 per cent., evener work and a net saving in waste of 1.33 per cent., beside the removal of a large amount of solid dirt, trash and sand, before the stock reaches the card clothing. It is only fair to say that at this time the "Connelly method" of feeding laps was applied, entirely preventing our previous trouble of split laps.

We have been more than pleased with the results obtained, and the saving in waste from these cards as they are running to-day compares very favorably with that from revolving top flat cards running in the Tremont Mills, as may be seen from the following comparative tests, made during the week ending Nov. 1, 1890. Tests were made on four different makes of revolving top flat cards, which for various reasons are designated as "A," "B," "C," "D," in the accompanying table.

Tests made during Week ending Nov. 1, 1890.

CLASS OF CARD.	Pounds of Cotton run.	Pounds of Strippings made.	Pounds of Fly and Dirt made.	Total Pounds Waste made.	Per cent. Strippings made.	Per cent Flyings made.	Per cent. Total Waste.
Revolving top card "A," . .	2,386	44.75	19	63.75	1.82	.77	2.59
Revolving top card "B," . .	2,185	49.75	12.25	62	2.21	.54	2.76
Revolving top card "C," . .	2,550	50.75	13	63.75	1.93	.50	2.43
Revolving top card "D," . .	2,269	41.75	6.50	48.25	1.80	.28	2.08
Foss & Pevey before changing,	33,795	1,245	150	1,395	3.70	.44	4.14
Foss & Pevey after changing, .	58,673	1,373	180	1,553	2.34	.19	2.53

From this table it will be seen that the total percentage of waste made from the Foss & Pevey Card after the shell-feed attachment was made compares very favorably with the total waste made on the revolving top cards.

From other very carefully conducted tests, covering considerable time and many cards, I present the following figures: 240,701 pounds of cotton were run through 75 Foss & Pevey cards in three weeks (these cards had not been changed, but were the regular cards), and 8,022 pounds of strippings were made, = 3⅓ per cent.; 2,117 pounds of fly and dirt, = 88 per cent.; a total of 4.21 per cent.

During the same three weeks, on 109 cards that had been changed 381,925 pounds of cotton were used, making 10,205 pounds of strippings, = 2.67 per cent.; 1,168 pounds of fly and dirt, = 36 per cent.; a total of 3.43 per cent.; showing a gain in saving waste of 1.18 per cent.

As a further test of seven weeks' trial on cards that had not been changed, 141,465 pounds of cotton were used, making 4,753 pounds of strippings, = 3⅓ per cent.; 1,376 pounds of fly and dirt, = 1 per cent.; a total of 4.33 per cent.

During the same seven weeks, 171,477 pounds of cotton were passed through cards that had the new feed appliance, and 4,408 pounds of stripps were made, = 2.57 per cent.; 427 pounds of fly and dirt, = 25 per cent.; a total of 2.82 per cent.; a gain in saving of waste of 1.51 per cent.

A test for the week ending April 2, 1892, eighteen months after feed motion had been applied, shows 132,680 pounds of cotton delivered cards, making 3,771 pounds of stripps, = 2.83 per cent.; 493 pounds of fly and dirt, = 33 per cent.; a total of 3.16 per cent.

The clothing on the cards is of hardened and tempered steel wire of English make, is No. 32 on cylinder set 55,000 points; No. 33 wire on doffer set 65,000 points; first 5 tops No. 30 wire set 48,000 points; next 12 tops No. 32 wire set 50,000 points; next 17 tops No. 33 wire set 55,000 points.

The cylinders of these cards are stripped once a day and the doffers twice a day. The cards are ground about once in six weeks. The weight of the lap is 11½ ounces per yard; the draft of card is 83.18.

About a year ago we applied this method of feed to 16 Whitehead & Atherton cards with most excellent results, and later have applied the same to 24 of the same pattern card. I have confined myself entirely to the Foss & Pevey and Whitehead & Atherton pattern cards; but the same excellent results are obtained by its application to the common thirty-six-inch card; many of them having been changed over within the past two or three years.

We think we are getting as good work to-day from these cards, at 85 pounds per day, as we are from the revolving top cards at 180 pounds per day, and practically the same amount of waste.

To have thrown these 280 cards out and substituted the revolving top flat card would have cost $120,000. No saving in floor space, and an increase in the power required to drive the cards; and, allowing the cost of labor to be the same, we should still have the interest on the $120,000, less the amount paid for the changes against us, and practically no better work.

It will of course be understood that the ideas advanced would not apply in all cases; but, here, the circumstances are that tl carding is on the fifth story of a mill fifty feet wide, with f lines of Foss & Pevey cards, while but three lines of revol top cards could be gotten in. Were we to build a new n

hardly think we should look to putting in the Foss & Pevey cards of the pattern that we have.

I understand that the card has lately been reconstructed and improved greatly, and promises to enter the market as a rival to the larger card, the stripping arrangement being very much improved; and there are to be more tops with clothing extending the whole surface of the same, making a much superior card of its class than has heretofore been built.

I do not know that I have anything further to say on this subject, except that on one of these cards we have lately applied a method of clothing on the tops, and are to-day running that card at 125 pounds a day, very successfully. The cylinder has been increased to 180 turns a minute. It is fitted up with steel clothing throughout, and gives very satisfactory results.

The nominating committee being ready to report, Mr. PRATT presented their report as follows: —

President, ROBERT MCARTHUR of Biddeford, Me.

Vice-Presidents, SIMEON B. CHASE of Fall River, Mass.; E. W. THOMAS of Lowell, Mass.

Directors, WILLIAM H. WHITIN of Whitinsville, Mass.; ALFRED M. GOODALE of Waltham, Mass.; WILLIAM J. KENT of New Bedford, Mass.; HERMAN F. SHAW of Manchester, N. H.; FRED. C. MCDUFFIE of Lawrence, Mass.; GEORGE W. BEAN of Lewiston, Me.

On motion, the foregoing report was accepted, and the gentlemen named were declared elected to the respective offices for which they had been nominated; the Secretary having been directed to cast one ballot in behalf of the Association.

President PARKER. In retiring from the chair I wish to thank the members for their uniform courtesy and kindness to me since I have occupied it, and I am very glad that the Association will be in so good hands for the coming year. Will Mr. MCARTHUR take the chair?

President MCARTHUR. Gentlemen, I thank you for the honor you have conferred upon me. I know that our commit-

tee could easily have selected one better qualified to preside over an Association like this. However, I accept your kind favor, and will serve you the best I can.

We will now proceed with the business that we have in hand. The first business will be the discussion of the paper that was just read by Mr. THOMAS. I hope the members will enter into the discussion and make it as interesting as possible. This is a very important subject to manufacturers who are now introducing the shell-feed to the card.

A MEMBER. Mr. President, I would like to inquire of Mr. THOMAS, what proportion of the whole amount he could account for in running through; in running 22,000 pounds of cotton, how much did he get in cotton, and how much did he get in waste and shell-feed and stuff in the card; and how much was there that could not be accounted for, if he took the pains.

Mr. THOMAS. Mr. President, no account was taken of that. What we did was simply done to find out what could be accomplished by putting the shell-feed in, and saving the actual fly from the cylinder.

Mr. HERVEY KENT. Mr. President, I would like to inquire of Mr. THOMAS how much of his success in getting the results which he did depended upon the use of shell-feed.

Mr. THOMAS. I can answer that question only by concrete figures, — that we made a saving of one and one-half per cent. of waste, which is a very material thing for us; and later trials within two or three weeks have substantiated that fact.

Mr. HERVEY KENT. The point I had in my mind was, how much the production would be increased by using the shell-feed over the ordinary form of rolls.

Mr. THOMAS. I have stated that we increased the production virtually from 65 to 85 pounds a day per card.

Mr. SOUTHWORTH. Mr. President, I would like to ask M THOMAS to say something about the quality of the yarn. ing out but one and one-half per cent. of waste, and putti the production from 65 to 85 pounds per day, was th quite as satisfactory?

Mr. THOMAS. I will state in answer to that, Mr. President, that on No. 29 yarn, practically 30 yarn, we increased the strength about five pounds, and by adopting double roving on spinning we increased it more; so we feel fully justified in using this method in trying to get all out of the card we could.

A MEMBER. Mr. President, I would like to inquire of Mr. THOMAS if he thinks there is anything else that contributed toward the results that he obtained besides the shell-feed.

Mr. THOMAS. One of the elements entering into the case was the adopting of the Connelly method of feeding laps in with fillet clothing on the cylinder. There is no question that these laps make better work and stronger yarn. We find now no droppings of cotton at the end of the doffers; and in cleaning out the inside of the cylinder we have only about one-quarter of the waste we formerly had. The room had 280 cards, and it was one of the dirtiest rooms to visit; but is to-day one of the cleanest I was ever in.

A MEMBER. I would like to inquire if this was single carding.

Mr. THOMAS. It was all single carding; yes, sir.

Mr. E. A. LEIGH. Mr. President, I think I can explain the difference there is by using the shell-feed from the old system of double-fluted rollers. The nip of the rollers was so far from the face of the taker-in that it drew the cotton in lumps, together with the dirt and short fibre, and gave the card wire a great deal more work to do. The introduction of the shell-feed was not quite successful at first, until they introduced the bevel to the feed plate to bring it down to the taker-in; and by that means they are able to comb the cotton and disentangle the fibres. Where two rollers are used, you will find if you turn back the lap from under the feed rollers that it is very ragged at the edges, and comes through in lumps. By using the shell-feed it opens the cotton, and gets a great deal of the dirt out before it gets on to the wire; and consequently it does better work, and you can do more of it.

Mr. JOHN KILBURN. Mr. President, I would like to ask if

I have been correctly informed by Mr. THOMAS' statement that he doubled his roving at the same time he put on the shell-feed.

Mr. THOMAS. It was done some three months after.

Mr. KILBURN. Were these results obtained afterwards or before?

Mr. THOMAS. They were before.

Mr. A. M. GOODALE. Mr. President, I do not understand from Mr. THOMAS whether the shell-feed was applied at the time the clothing was changed, or at a different time.

Mr. THOMAS. It was put on at the same time; the changes were all made at once.

Mr. F. M. MESSENGER. Mr. President, I would like to ask Mr. THOMAS if, on the fine yarns where the shell-feed carding is used, he would recommend applying the licker-in and shell-feed to the breaker cards, — if he thinks it would pay to do so.

Mr. THOMAS. In regard to that question, Mr. President, I should say that it would pay. I should not think it would pay to substitute the double roll on fine yarn; but for putting the cards in better shape, and keeping the stuff off from the breaker cylinder, I should think it is a very good thing. It has been adopted in some mills with very good results. I did not know but we should get some testimony here to-day to substantiate that.

Mr. WILLIAM J. KENT. Mr. President, I should like to ask Mr. THOMAS one question. I was not quite satisfied with the answer he gave Mr. SOUTHWORTH in regard to the quality of yarn, with the shell-feed. There is something more than the strength of the yarn to be considered.

Mr. THOMAS. I would say that our yarn appears stronger than it was before. We want no better evidence. The work is much cleaner than it was before, and we are now using a lower grade of cotton than we used to.

A MEMBER. I would like to ask Mr. THOMAS in regar the condition of these cards and clothing before they changed.

Mr. THOMAS. I will state, Mr. President, that th

have been in and running from six to ten years; and the clothing now of a great many of them is in very good condition. In some others it is rather poor; but we are making a clean sweep, and put on the best clothing we can buy to-day, and are putting it on the cylinder.

The PRESIDENT. I infer that you did not make the change at the same time you put in the shell-feed.

Mr. THOMAS. Yes, sir.

The PRESIDENT. You did make the change in the clothing?

Mr. THOMAS. Yes, sir.

Mr. HERVEY KENT. Mr. President, I was in Mr. THOMAS' mill not many weeks ago; and I saw a card which they told me was running at 150 pounds a day. It looked remarkably well. Mr. THOMAS was doing a great deal more than his paper has shown.

Mr. THOMAS. The card that Mr. Kent refers to is the one I speak of as having the tops all covered with wire; being tested by a gentleman in Lowell to see what can be done. That card is now running at 125 pounds per day, that one card, with very satisfactory results.

Mr. JOHN K. RUSSELL. I would like to ask Mr. THOMAS how much of this gain in product he attributes to the extra carding surface obtained, through covering his cylinders with fillet in place of sheet clothing; as I understand him they were ormerly covered with sheet clothing.

Mr. THOMAS. I will state that our success in working that room to-day is due to the fillet clothing and shell-feed. We took off the old clothing and put on new fillet clothing, knowing that it was a step in the right direction to increase the speed of the cylinder. I will state, Mr. President, that we made this move because, having these cards on hand, we considered them too good to throw away. We have in one of our mills 180 revolving top cards, from which we are getting most excellent results. We thought we could use the Foss & Pevey cards five or six years by improving them; and the result seems to show it was a proper thing for us to do. We did it, and

we feel we have been justified in going to the small expense we have in getting a good card.

Mr. S. N. BOURNE. I would like to ask Mr. THOMAS how many cards he runs on each railway head.

Mr. THOMAS. Well, nine cards. There are about eight running all the time.

The PRESIDENT. Eighty-five pounds each card?

Mr. THOMAS. Yes, sir.

Mr. D. M. THOMPSON. Mr. President, I came in late, and have not had the pleasure of listening to the presentation of the subject; but I can see that benefits may be derived from the licker-in and shell-feed system as now applied to cotton cards. It is doubtless an important matter. It occurs to me there may be some members present who have had experience with the shell-feed, under the conditions that existed in reference to its clothing prior to the application of the roll. I think the subject is so important that it ought not to be left without some further information, if it is obtainable. It seems to me that the trial, if made simultaneously with the application of fillet clothing that adds thirty per cent. of wire, would have a tendency to mislead in reference to the merits of a shell-feed. I simply suggest the matter, but do not propose to discuss it. If there are members present who have had that experience, it would be very valuable to the Association if they would present their views

Mr. GARSED. Mr. President, some years ago we imported a large quantity of cards. Their feed was shell-feed, but in watching the operation of the card we found the cotton was torn through by snatches, as we found, in this double-carding yarn. Looking into the matter, we found that there had been no provision made for the accuracy of the roller to fit into the shell when the edge of the shell terminated parallel with the edge of the licker-in. The consequence was that we had very bad work. This was from bad workmanship on the part of the machinist, and not bad principle in the machine itself, and it comes under the same head that you have heard me speak of several times in this room. That is, we do not pay enough

money to have the machine properly made. A shell-feed is very valuable if it is properly made, but it is the most miserable thing in the world if it is badly made; so it comes right back to this,—make the machine right, put money into the machine to make it perfect, and you will have the best machine in the world. I think the trouble has been heretofore from want of proper workmanship in making the shell-feed.

Mr. O. S. Brown. I would like to ask Mr. Thomas a question in regard to a matter that struck me as being very peculiar. We all know that split laps are very troublesome, and I find he has corrected that on his card. I would like to know if he can give me any idea how that was corrected there. Did he relocate his laps? Why didn't it split, if it split on his old card?

Mr. Thomas. I do not know that I have ever seen a split lap in the card room to which I referred with the Connelly method in use on these 280 Foss & Pevey cards; whereas before it was a constant and serious trouble.

Mr. Brown. Do you use a Connelly feed, Mr. Thomas?

Mr. Thomas. Yes.

Mr. Brown. On all your cards?

Mr. Thomas. Yes.

Mr. Brown. And they split, with Connelly feed?

Mr. Thomas. Yes, sir. I will state we have used the Connelly method on the English cards with very satisfactory results.

Mr. Southworth. Mr. President, in further reply to Mr. Brown's question, I will say I have applied the shell-feed to 45 Foss & Pevey cards, making no other change in those cards excepting to speed the cylinder from 130 to 155; a perceptible advantage in the quality of the work being shown. I am not able to give any figures on it, but it is a matter of judgment.

The President. We changed at one of our mills one section of the breaker cards to shell-feed; I have no figures to present as to the result, but the improvement to the carding was very evident. We intended at that time to apply the shell-feed to all of our common American breaker cards; but, later, we concluded that the cards in this particular mill

should be taken out, and the revolving top card substituted; but I know that the shell-feed is a good thing. How good it is, and how much it did for us, I cannot say.

Mr. BROWN. Mr. President, at the time you changed your shell-feed did you change the licker-in?

The PRESIDENT. We applied the licker-in at the same time.

Mr. BOURNE. Did you have the licker-in before?

The PRESIDENT. No, sir.

Mr. FLATHER. Mr. President, I would like to ask Mr. THOMAS if he applied the licker-in and perforated screen in addition to what he has already stated.

Mr. THOMAS. We applied all these things to the cards at the same time. The trouble was putting on the perforated screen to the licker-in, and one adjustable knife, so as to be set up closer or further away. The work was done by the Lowell Machine Shop.

Mr. O. S. BROWN. Mr. THOMAS made a great many changes on his card, and they were all good, I have no doubt; but I am very confident that some men have put the shell-feed on their cards, and made no other changes. I trust we shall hear from them. Mr. KENT, do you know of anybody who has tried it?

Mr. HERVEY KENT. If you refer to me, I should say no. One point I would like to have brought out is, what is the cost of simply the shell roll; where you have a licker-in now, and make the change?

The PRESIDENT. I presume Mr. FLATHER could tell us about that.

Mr. FLATHER. Well, we have nothing definite regarding the cost. We did some work for the Pepperell Mills, and if I remember correctly, it was something between thirty and forty dollars per card; but we never advocated putting them on unless a licker-in screen and knives were also applied, and it is probably doubtful if the desired results would be obtained without them. The shell-feed is very good in itself, but does not add any more than Mr. LEIGH has given it credit for. So as far as being able to run any more through a card, or other advantage, is con-

cerned, probably the reclothing of the cards, and putting on fillets instead of sheets, had more to do with it than the shell-feed.

The PRESIDENT. When we applied the shell-feed, we also applied the licker-in at the same time. Some of the members may infer that the advantage came from the licker-in rather than the shell-feed; but I do not think so. I am of the opinion that the good results produced are pretty evenly divided between these two appliances.

Mr. BOURNE. Mr. President, I would like to inquire if there is any one who has had the licker-in with the rolls, who has just taken the rolls out and put in the shell-feed with the same licker-in, on breaker card; and if they always had the licker-in with the rolls, and used this saw-tooth fillet.

Mr. A. F. KNIGHT. Mr. President, it seems to me that the use of the shell-feed implies the use of the licker-in. In my experience, on a plain card, and also on a Foss & Pevey card, and on the Foss & Pevey card more particularly, the use of the licker-in without the shell-feed, that is, with the ordinary feed rolls, has caused the cotton to be delivered in bunches. It seems to me that the shell-feed would overcome the delivering of the cotton by the licker-in to the carrier or to the cylinder in bunches; and in that way it becomes an advantage. I would like to ask Mr. THOMAS what was the condition of the cotton on the licker-in, before he adopted the shell-feed.

Mr. THOMAS. I will state to Mr. Knight that we changed our licker-in when we put on the shell-feed, but, on the old system of carding, our licker-in was always jammed up full of clots. It never seemed to take the cotton from the rolls in the condition it should be. By putting a shell-feed in the old licker-in we might have got some little benefit; but certainly experience has shown that the saw-tooth licker-in is one that should be used in connection with a shell-feed, as giving a better result. We now get a very clean surface. The lickers-in are always clean. The leader takes the cotton away from it very nicely.

Mr. GARSED. Mr. President, Mr. LEIGH's work on cotton-carding shows that the work can be done as well without a

licker-in as with it. There is no trouble about that; but, from the remarks made here, I think you might be led astray. Some gentleman has stated an increase of cylinder speed would be a benefit. Now, if an increase of cylinder speed would produce the result, there is no necessity of putting a shell-feed on. Do you see the point I try to make, — that, if the centrifugal velocity of the cylinder will throw off the fibre of cotton and will make an increase in the production, there is the element of success, or otherwise? It does not follow, that a shell-feed can only be used on a card with licker-in. It can be used on cards without licker-in, by simply turning the plate, or shell, so that the roller, in shell plate, will be under the plate instead of over it. It is illustrated in the books of Mr. ——, and shown in works on carding. Perhaps some gentleman present can tell us whether the increase of speed from 150 to 180 will give his work equally well carded or equally well done; or any other increase in the velocity of the cylinder.

Mr. O. S. Brown. Mr. President, I cannot answer from personal observation that question; but, talking with a manufacturer a few years ago, he told me he had decreased from 140 or 150 down to 120. He made very much less waste and very much better carding.

Mr. Garsed. That would seem to answer the question.

The President. The tendency seems to be to high speed on the cylinder.

Mr. Hervey Kent. Mr. President, the point to my mind is the quality of the work. We have some cards, made a good many years ago, and we are obliged to run the cylinder at low speed, because in the first place, the shell is not thick enough. There is not stock enough in the cylinder. We are obliged to run them slow. It seems to me if you are going to accomplish much by the card, you want it so you can run it with some speed, and it has got to be built with express reference to that. With the old appliances you can hardly run it 165 or 175 without confining it in its boxes; as we can in best modern cards.

The PRESIDENT. If there is nothing more to be said on this subject, we will take up the next topic, "Is the production of a mill increased or diminished by stopping for Saturday half-holidays?" The discussion will be opened by Mr. F. M. MESSENGER of North Grosvenor Dale, Conn.

Mr. F. M. MESSENGER. Mr. President, it seems to me that other papers to follow will be very interesting, and something must be crowded out here to-day. The other subjects are of a great deal more importance to the Association than this one; and, while I do not desire to shirk any responsibility whatever, I would ask, in the interest of the Association, that this paper be omitted; and I hope the Association will grant permission to omit it.

A MEMBER. Mr. President, if Mr. MESSENGER is prepared, I would like to hear from him, for one, for it is quite an important question.

Mr. MESSENGER. Mr. President, I will say I have not prepared a paper. (Laughter and applause.) I did not suppose that, under the new order of things, we would be expected to prepare an essay. I had the idea that we were expected to say a few words in opening a subject, just simply to start the discussion. I will say that only from my so understanding the matter would I have accepted this part of the programme; for the reason that our mills have never adopted that system. We never have run the mills where I am on the Saturday half-holiday principle. I need not say, therefore, that I have not been in favor of it. Where we are, it is one of those things that bring an irregularity into our work, and break up our system more or less; and, unless there is some other thing that enters into the consideration, I will say that, on general principles, I believe it is objectionable to break up your system by running extra time for five days, in order to stop work a little earlier another day. I can imagine, in some localities, in the case of a mill located perhaps near a large town, where the operatives can go shopping to advantage and profit, that the change might be so beneficial to them that a refusal on the part of the company or corporation to grant it might work to their

injury as a whole. Perhaps in cities, where the operatives have less opportunity to get out in the fresh air in the summer season, it may be that the advantages derived from having the Saturday half-holiday, and being thus enabled to get out without losing their time, would be sufficient to warrant the change. In such cases the advantages might more than off-set the disadvantages; but, on general principles, my opinion is that, unless there are some such considerations as these, we can do better work both in quality and quantity by running regular hours through the week. I base my opinion on this fact, that in any week that a holiday occurs we have almost invariably realized a lessening of production, and an increase in the second, or lower, quality of goods; and, if that is true of an occasional holiday thrown in, it seems to me it must be true where we work extra hours to obtain a half-holiday.

There is another point. People who have been agitating the subject of short hours, as I understand, always objected to getting the young people up so early in the morning to go to the mill; but, since we have got the ten-hour law out in Connecticut, they want the Saturday half-holiday; and, in order to do that, get up a little earlier, and work a little later, than ever before; so as to get out Saturday afternoon. We never felt the necessity for the change in our locality, and never adopted it; but I can see that in some localities it might be a good thing. I think it would be difficult, however, for us to agree on the matter, if we decide it intelligently, each from his own stand-point.

A Member. Mr. President, in reading the question as it is presented in the programme, it is, "Is the production of a mill increased or diminished by stopping for Saturday half-holiday?" It leaves the question open whether that is intended to be an inquiry in regard to the loss of the half-day or making it up in some part of the week, as suggested by Mr. Messenger. I think the question as it stands would look as though the mill was simply to run on regular time until Saturday noon, and then stop; but I noticed that Mr. Messenger's argument was wholly on the ground of making up the half-day. I

would like to ask whether, to his mind, that would make any difference. I was not quite clear on which side of that point he was.

Mr. MESSENGER. I did not understand the question that way. Perhaps that was the intention of it. If it was, it seems to me it must be, inevitably, less productive to have a mill stop for a Saturday half-holiday; lessening the running hours of the mill to that amount. For instance, we stop now at three o'clock Saturday afternoon. If we should stop at noontime, I do not see how we could possibly make up the loss in the production that would be entailed.

Mr. GARSED. Mr. President, in Pennsylvania we have to make sixty hours a week. The law does not tell us to make it all in six days or five, but we make sixty hours a week, and stop at twelve o'clock on Saturday. That is the rule throughout Pennsylvania, as far as I know. We actually make the time, but we make the sixty hours in five days and a half.

Mr. HERVEY KENT. Mr. President, we have been running on five and a half days' time, making the sixty hours in that way, now for several years; and I believe that the help are so well pleased with it that I would about as soon think of running a mill without oil, as undertaking to turn the current the other way at the present time. We do it, however, only in the summer months, when we can do it without any extra expense for gas. I am inclined to think that we get more work and better work, because the help enjoy it better, and it gives them an opportunity to have half a day, consequently they will work more steadily the rest of the week; and we have been able, from the fact that we put in our time in five days and a half, to make up for all lost time except holidays. As we run ten hours and fifty minutes, for five days, every holiday we lose the fifty minutes which we make up; and that makes it easy, to make up for all stoppages. The principle is to make the help just as contented and happy as we possibly can.

Mr. MESSENGER. Mr. President, while I appreciate the point Mr. KENT makes, at the same time I think in some local-

ities there is a call for that, and in others not. I would like to ask Mr. KENT if he increases production in that way. If he does, he could have increased it but very little more, I should think.

Mr. HERVEY KENT. I have no figures whereby I can answer that question directly, but I believe we get more and better work if the help are contented and happy.

Mr. N. B. BORDEN. In Fall River, in the summer season, a good many of the mills have adopted the Saturday half-holiday method of running their mills. My personal experience has been that, when we run until three o'clock Saturday afternoon, we weave more cuts per loom than when we stop at twelve o'clock; and the reason is that the help clean up a good deal during the noon hour; and if we stop at twelve o'clock Saturday noon they either do their cleaning while the machines are running and during mill hours, or else they do not do the cleaning thoroughly. I think we can weave more cloth by running until three o'clock Saturday afternoon. However, we have adopted the method of stopping at twelve o'clock Saturday. We have more looms than we can spin for, and consequently can weave all we do spin. We think we can spin as much yarn by stopping at twelve o'clock as by stopping at three o'clock Saturdays; and having more looms than we can spin for, we are satisfied to run that way. We know the help like it better. It gives them time to attend to recreation, see football games, and enjoy themselves; do their shopping, and some of their household work. But the prospect is that we are going to have a fifty-eight-hour bill in Massachusetts, and we shall all have to stop at noontime then, and shall know all about how it will affect us.

Mr. FRANK HASKELL. Mr. President, down in Maine we are located only about six miles from the city of Portland, ar our operatives like to have the advantage of shopping in t city, and also in the summer time of a trip to the islands the afternoon; and some of our help take that trip and t over Sunday; and the result is increased health on the pa the operatives, and an increased product to our corpor

In Maine under the ten-hour law we work our sixty hours per week, starting in the morning at six o'clock and working until six at night. We start at six and stop at eleven o'clock on Saturday, which we find equivalent to a stop for cleaning; as the weavers are ready to stay in until noontime to do their cleaning; so they are all ready to start up Monday morning with the looms in good shape, and our help prefer this method. We thought they would soon get tired of starting at six o'clock in the morning; but they like it, and we have continued on that schedule, ever since. We are using the electric light, so the cost of lighting need not be considered. We would not go back to the old system. We are without doubt getting a larger product on account of the Saturday afternoon holiday than we should get if we ran Saturday afternoon. Our work is such that some of our weavers make over ninety-eight per cent. of theoretical product on the looms of finished goods; which I think is about as high as it is possible to go. Our average product for a whole six months for all looms, without allowing for any stoppages whatever, is eighty-five per cent. The principal benefit we have is in the health of the operatives. During this last winter it has been very sickly in our city, but our mill operatives have undoubtedly been in better health than the same number of people outside in the other parts of the city. We have had no sickness to speak of, and have run steadily right through the winter. We find also an increase in the steadiness of the work. Day after day the help are constant. If you look over the pay rolls you will find full time for the majority of the help. Especially is this the case with the weavers; which requires, of course, fewer spare weavers and fewer spare hands in the other parts of the mill. We have never compared the winter schedule with the summer, as we have run the same schedule right through the year, and you may say our figures are of no value; but we feel, in comparison with other mills in other places where they do not have a half-holiday Saturday, that it is an advantage both to the help and to the corporation.

Mr. Messenger. I would like to inquire at what speed you run your rollers.

Mr. HASKELL. One hundred and forty-three, colored work; six-box looms.

A MEMBER. Did I understand the gentleman correctly that he got ninety-eight per cent. product from the looms?

Mr. HASKELL. Yes, sir. We had two weavers for two weeks in succession who got a little better than ninety-eight per cent.

The PRESIDENT. If there is nothing more to be said on this subject, we will proceed to the next topic, "What is the best policy to pursue in manufacturing concerns having large quantities of similar machinery; whether to have one overseer over a large amount of work, or to distribute it among two or three overseers." The subject will be opened by Mr. CHARLES D. McDUFFIE of Manchester, N. H.

Mr. CHARLES D. McDUFFIE. Mr. President and gentlemen, the question that you have before you to-day for consideration is one where there is a chance for an honest difference of opinion. One may believe in No. 32 wire, and another one may believe in a finer wire, so there is a chance for an honest difference of opinion. But this question under consideration, as you have given it to me, runs something like this. (The speaker then read the topic.)

Gentlemen, we are all doing that thing. That question is settled. I do not think there is any chance for a difference of opinion among us. I have but very little to say about it, and I think there is not much of an opportunity to antagonize the question; because the party who antagonizes it will antagonize himself most decidedly.

One man who has the executive ability and adaptation can handle help and machinery with better success, in the same yard, than when divided among two or three men. It may be answered that it would be better to employ three; as the chances are that the larger the number, the more likely the employer to secure elements not to be found in one man; and said elements might assist in setting the pace for product,

quality and discipline. To this I would reply, that we are supposing that the best one of all would be placed in charge, and the responsibility has a tendency to develop the man to meet the requirements of his employers; one system holding in all the details of management of help, also in the care and repair of machinery.

Thirty years ago it was a rare occurrence to find a man in charge of more than one floor of a mill; when mills were not so large as have since been built, it was not uncommon to find two men in charge on one floor. I remember one of the first mills I worked in, there were seven hundred looms on print cloths, two men in charge, each trying to produce more yards per week than the other, with the result that the quality and the discipline were seriously affected.

These and other causes have changed the methods of management toward larger responsibilities for men in charge of departments; and I think with better results. I do not think that the change has come from the money saved in employing a less number of men; but from better results, as shown by a better management. Nor would I call your attention to the fact that where you can use one man in place of two you save a small amount of expense; for the best system is of greater importance (toward earning a dividend by making better goods at less expense) in the management of a large number of machines by one man, than by using three for the same purpose.

The PRESIDENT. We would like to hear any gentleman who feels disposed to say a word on this subject.

If there is nothing to be said, we will pass to the fourth topic, "What has been the result of experience in bringing the power from engines or water-wheels into the mill, at the end or in the centre, in mills of not less than 350 feet in length?" The discussion is to be opened by Mr. JOHN KILBURN of Lowell, Mass.

Mr. KILBURN's paper is as follows: —

QUESTION. "What has been the result of experience in bringing the power from engines or water-wheels into the mill,

at the end or centre, in mills of not less than three hundred and fifty feet in length?"

1. Cotton manufacturing began in this country by utilizing its water powers, and at these beginnings water-wheels were limited in power; and for this, and also for financial reasons, short mills, say 100 to 150 feet in length, were built, and the power applied at one end.

2. When larger mills were wanted, they were frequently built across the valley of a stream, and two wheels were placed in the centre; to utilize the full power of the stream without digging canals or turning a corner with the power, and for the further reason that the art of making shafting was in its infancy, and 100 to 150 feet was as long as a line would work well; and for these reasons power was applied at the centre.

3. The application of power at the centre of mills, with numerous cumbersome belt boxes, took much valuable room and virtually divided each floor of the mill into two rooms.

4. When steam power began to be used to drive cotton mills in this country, the limitations of shafting led to the application of power at the centre of mills, for a material term of years; and this method necessitated the building of an L, or a separate building in the rear of the centre of a mill; either of which shut off much light; and, in many cases, one tower with stair-case was deemed sufficient for mills not over 350 feet long, and this tower was usually placed at the centre and on the front side of the mill; so that the tower and rear building, together with the belt boxes, shut off all valuable light from the centre of the mill, and in effect divided each floor into two rooms.

5. The introduction of turbine wheels concentrated water power; and this advantage, together with the fact that several of them could be coupled together, so that a very large amount of power could be concentrated, enabled mill builders to change the arrangement of mills to be operated by water power, so that they could be built of any length.

6. The wonderful improvement in steam engines has also concentrated vast amounts of steam power, and made it specially applicable to long mills.

7. Long mills permit the placing of towers not opposite each other; and hence they do not shut out much light.

8. The wonderful improvements in the art of making shafting and belting have also made the operation of long mills practicable.

9. I can best convey an idea of the improvements in shafting by calling your attention to the construction of the Amory Mill at Manchester, N. H., and the application of shafting to one of its rooms. This is a ring spinning room, containing 31,216 frame spindles, 1,500 spooler spindles, 20 warpers and 2 slashers. This room has but one line of shafting to drive the entire load. The power comes up on to the head end, which is 5¾ inch diameter, with 4½ inch bearings. The line runs the entire length of the mill, running at a speed of 455 revolutions per minute, with sizes and lengths of shafting as follows, viz.: 105 feet of 2⅝ inch diameter cold rolled shafting; 231 feet of 2⅜ inch diameter cold rolled shafting; 167 feet of 1 15/16 inch diameter cold rolled shafting.

10. Competition has led manufacturers up to the necessity of building mills so large, that as much machinery can be placed on one floor as one overseer and one second hand can take care of.

11. In conclusion, I feel that I am justified in saying that the improvements in motors, shafting and belting, aided by experience and competition, lead me to conclude that all mills, whether 100 or 600 feet long, should have the power applied at one end.

Mr. Messenger. I did not learn why Mr. Kilburn favored applying the power at one end. Perhaps he gave it, but I did not catch all he said about it.

Mr. Kilburn. Simply, the concentrated power keeps your wheels all in one spot; and avoids the darkening of your mills by either towers, or auxiliary buildings, located in the centre for water-wheels or steam engines.

Mr. Garsed. Mr. President, we built a mill in 1853, 500 feet long and 66 feet wide, with the engine in the middle. From that time to the present I think two shafts have probably

given out in the picker room, where the girders gave way; therefore I should judge that it was a pretty good system to have the driving power in the middle of the mill. There are 20,000 spindles in that mill, and they have been running ever since 1853.

Mr. KILBURN. Mr. President, it may not be out of order for me to state that, years ago, we did not put upon the ordinary shafting more than one-third the load it was capable of bearing. I think the rule followed years ago by A. D. LOCKWOOD, of obtaining the power of shafting, was to cube the diameter, divide by the velocity in revolution, and multiply by 100. To-day in using ordinary shafting we usually divide by 33. The way ordinary shafting is made to-day, it is capable of bearing three times the load that was formerly put upon it. A cold rolled iron or cold rolled steel shafting is capable of bearing twice as much as ordinary iron; or, fall a little below that, and call it $1\frac{7}{8}$ to 1. I see Mr. KNIGHT of the Amory Mills here to-day. He can tell us what the result has been by the use of shafting in that mill, some of which is smaller than I have spoken of.

Mr. KNIGHT. Mr. President, I can only say that the transmission of power in the Amory Mill is very satisfactory. The only peculiarity that I have noticed in the spinning room is that the shafting runs at very high speed, enabling us to use very large pulleys on the frames. We use a fourteen-inch pulley to drive 240 spindles; and we have no slipping of belts. In one of our mills we put in some spinning frames very similar to those in the Amory Mill, and both run 9,000 revolutions on No. 28 yarn. We did not get the yarn per spindle, that we did in the Amory Mill; very much to my surprise. On inquiry into the cause, I found that, as the bobbin was filled, the load became heavier on the spindles, and the belts were slipping. We did not get the speed on the front rolls that we did when they began with empty bobbins. The size of the frame-pulley, there, was nine inches. The pulley on shafting was something like 34 inches, I think, in diameter; but passed up through the floor onto the nine-inch pulley; as you see,

covering only a small part of the circumference of the nine-inch pulley. In the Amory Mill we have no trouble of that kind. The slipping of belts, or anything of that kind, is almost an unheard-of thing.

Mr. Wm. J. Kent. Mr. President, when I was at the Grinnell Mill we had our belts all at one end; and we were thereby enabled to raise them up and get rid of the dirt, and passed the belt through the belt hole from one room to another.

Mr. Bourne. Mr. President, I would like to inquire about the cold rolled shaft. I have had a little experience, and my experience has not been wholly satisfactory. I put in some a number of years ago. Whether I have had poor luck, or not, I cannot say.

Mr. Kilburn. Mr. President, I would say, as the result of my experience, that I occasionally get a poor shaft made of cold rolled iron; and when I do I send it back to the manufacturers and tell them to send me a new one, and I get it.

The President. We had a steel shaft in one of our mills that broke, and was renewed, several times; finally we got disgusted with it, and threw it out, and put in its place a common iron shaft of the same size, which has given us no trouble.

Mr. Kilburn. I have not been troubled with the iron shaft. The brittleness of the steel shaft makes it objectionable, and I have avoided its use; but I have found extreme satisfaction in the use of the cold rolled iron, as far as my experience has gone.

Mr. Messenger. Mr. President, I presume the first cost of shafting would be considerable, would it not?

Mr. Kilburn. Of course the less shafting, the easier it is to run.

Mr. Parker. It does not seem to me that the advantage of taking power into the end of the mill has been proven. On the other hand, I think that, as mills are belted to-day, — and no one perhaps would think of building a mill without putting the belting within a closed room or belt tower, — there is just as much light cut off from the machinery as if the belts were taken in at the centre or the engine room, and the belt tower

were placed in the centre of the mill, rather than at the end. At a mill in Lawrence there is a belt tower about 12 feet square that contains all the belts which drive the mill; requiring about 1,200 horse-power. Those belts enter the mill horizontally, without interfering with the running of the machinery. Possibly there is a little trouble in arranging the counter-belts which are needed near these main belts; but aside from that there is no interference, and there is no trouble whatever in bringing the belts in where they belong, and getting power on the main shafting. The suggestion that the shafting would have to be larger if the power enters at one end of the mill is a vital one; making the shafting cost more than it would if you should take your power in at the centre of the mill, especially where the power at the centre of the mill can be quickly distributed from that point. Several mills that I am acquainted with have the picking department, for instance, at the opposite end of the mill from where the engines are; and a very large amount of power has to be taken over a large shaft the whole length of the mill. There, of course, the application of the power at the centre of the mill or nearer the picker room would be of obvious advantage; but as mills are ordinarily arranged, or, we will say, with the best arrangement that it is possible to make, there is no doubt in my mind that the shafting could be placed in a mill for less money where the power was taken in at the centre than at the end; and I cannot see how there would be any less light in the mill so arranged. In the case of the Lawrence mill the shaft runs across the mill, and the belts are run with a quarter turn; and where the belts enter the different rooms they run over carrier pulleys. We have never had any trouble with these belts. All are 20 inches wide, and two of them over 240 feet in length; and they have run eight years.

A Member. What percentage of the total power is used in driving the shafting and loose pulleys, belts, etc.?

Mr. Parker. I cannot give any figures for that mill; but I can quote from a paper which Mr. Sheldon should have read here at the last meeting, where he states that the least friction

which he has ever found in a mill is 22 per cent. of the total power, and the largest friction he has ever found in a mill he states as 39 per cent. The average friction for shafting, etc., probably would range somewhere between 23 and 30 per cent. I should not think a mill was running excessively heavy if the friction load was 30 per cent. of the total load. I should think it was very light if it ran as low as 22 per cent. I see several mill engineers here, and I would like to hear from them.

Mr. JOHN KILBURN. I do not think that Mr. SHELDON'S calculations are of any value unless the two mills are doing exactly the same work, running exactly alike.

Mr. KNIGHT. I would say to Mr. PARKER, that our shafts, pulleys, etc., were tested by Mr. MANNING a week ago last Saturday; but there were some elements of uncertainty. We drove three wheels, and had one disconnected; and we assumed that the three wheels required about the same power, each, as the one that was disconnected; deducting the same amount of power for driving each of the three wheels that it took for the one that was disconnected. The power that was used for driving the shaft, pulleys, etc., was less than 20 per cent. of the total power of the mill.

Mr. PARKER. Did that include the main driver?

Mr. KNIGHT. That included everything, the engine as well; but, as I said, there were those elements of uncertainty that could not be tested.

Mr. BOURNE then stated that he had used for a short time a friction coupling; a model of which he had with him, and exhibited, explaining the method of its use. He stated that with it he could drive 300 horse-power; that he had one doing that, running 500 revolutions a minute. With its use he said he could start, and stop, a shaft, without anybody knowing it in the other parts of the mill.

The PRESIDENT. Undoubtedly that is a good thing, if Mr. BOURNE has no stock in the company.

Mr. BOURNE. I have not any yet, but if it is put on the market, and the price gets down to a lower figure, I do not

know but that I shall go in; but the man who owns it says he is not going to sell it.

Mr. STEPHEN GREENE. I would like to ask Mr. PARKER if he understands that the per cent. which was taken did not include friction on the engine, as well as the friction on the shafting. It is very important for us to know, in speaking of friction, whether that includes the motor or engine, or simply the friction of the shafting and belting.

Mr. PARKER. I understand it includes the friction of the engine.

Mr. GREENE. Then, when we are speaking of loss in driving shafting, whether it is taken in at the end or the centre, we want to consider the question of shafting alone; not the question of friction on the motor.

But I would like to say while I am up, Mr. President, in regard to taking this power at the end or centre, I really did not know before coming here to-day that there were two opinions on the question. I supposed it had been pretty clearly settled that it was best to take power in at the end; but I am very glad to get all the information. It seems to me we must consider this question, that probably larger mills are to be built in New England in the near future, or at least in the future; and they must be driven by steam power, and in driving from an engine we like to drive as directly as possible. In my own experience I have avoided carrier pulleys and intermediate pulleys, as far as possible. I like to get power directly from the fly-wheel of the engine to the head of the main shaft, and to do that we must take that power in in such a form as would not injuriously affect the room. That is the reason we prefer to have a belt tower that will contain the belts. If we had that, we should certainly desire to have that at the end of the mill; not to cut the mill in two and have two divisions of the mill. In that view I can understand Mr. PARKER'S case, where the shafting is below the level of the floor, and at right angles with the shafting; where he is obliged to take it in by a quarter turn of the belting. He does it in that instance without any very great loss of light, and without any division of the mill.

Mr. HERVEY KENT. If a mill is belted properly in one end, and the shafting arranged, and the machinery with the shafting, I claim it can be put in for the same money as the new belting and shafting.

Mr. KILBURN. I would like to ask Mr. GREENE, in connection with his remarks, if he thinks it will be better to put his pickers in as he suggests, rather than put them in at the opposite end as suggested by my friend Mr. PARKER.

Mr. GREENE. I should probably agree with Mr. PARKER. I should certainly place the picking, which takes so large an amount of power, as near the engine as possible, and not at the opposite end of the mill.

Mr. KILBURN. I thought he described it at the opposite end of the mill as the reason why it took more shafting.

Mr. D. M. THOMPSON. Mr. President, in responding to the request for my views upon the subject, I will simply say, I have generally preferred to apply the power at the end of the mills; for the reasons already stated by Mr. KILBURN and Mr. GREENE. It is important to reach the main lines as directly as possible, and avoid intermediary shafts. I have applied the power at the centres with very satisfactory results; in some cases enclosing the head shafts within towers upon the side of the mill. There are some advantages in the reduced sizes of the shafts required for distribution as compared with long lines. There has been a considerable improvement in the quality of material and the manufacture of shafting during the past twenty or thirty years. We run our shafting at such speeds as easily admit a much greater length than formerly. The tendency is or has been towards high speed upon machinery, for the purpose of a larger production as compared with even ten years since. This increase of speed is at the expense of power; but the conditions are usually such as admit a choice in the selection of the points of location for the motors, and I regard them as generally more satisfactory when located at the ends of the mill.

Mr. CHARLES R. MAKEPEACE. Mr. President, about three years ago I was called on to make plans for a 26,000 spindle mill. The agent of the mill was a careful man, and went into all the

questions involved very thoroughly; and especially this question of the best way to shaft the mill. At his request two plans were made; one showing an arrangement of machinery which brought the power in at the end, the other in at the centre. When the schedules of shafting were made out, they were submitted to four or five builders of shafting, all responsible parties; and much to our surprise the greatest difference in the proposals was only $17.41.

I have been very much interested in Mr. KILBURN's paper on this subject; but would like to have him repeat the formula he gave for determining the size of cold rolled shafts.

Mr. KILBURN. The cube of the diameter divided by the velocity in revolution, and multiplied by nineteen.

Mr. MAKEPEACE. That is a very good formula so far as it goes; but tells us nothing unless we know the length of the bay, or distance between bearings. Whether he applies this formula to bearings six, eight or ten feet apart.

Mr. GREENE. Mr. President, I would like, without taking up any more time, to make a simple correction. Two references have been made to Mr. LOCKWOOD's formula; and I only deem it right to say that the formula stated by Mr. KILBURN was never used by Mr. LOCKWOOD, as far as I have knowledge.

Mr. KILBURN. Prior to your day?

Mr. GREENE. I say, as far as I have knowledge.

The PRESIDENT. If there is nothing more to be said on this subject, we will proceed to the next topic, "The use of single or double boss rolls on spinning frames; from which can be derived the most benefit?" The discussion is to be opened by Mr. WILLIAM J. KENT of New Bedford.

Mr. KENT. For many years I was led to believe that the double-boss roll on spinning frames was far superior to the single. About four years ago I put into the Wamsutta Mills a large number of new spinning frames, and this subject was discussed very thoroughly at that time; we at last decided to adopt the single-boss rolls; but even then I was not convinced that they would produce so much better work than the double-boss could.

Since that time we have tried many experiments; and I am now thoroughly convinced that more even, and consequently stronger, yarn can be made with the single than with the double boss rolls. Some of the most important advantages I will name: —

1. It is almost impossible to make double yarn; and this is of great moment in mills making fine yarns, and, in mills where they sell their product, it is even greater. The distance between the ends as they are delivered from the rolls being so much greater, — in one case $2\frac{3}{4}$ inches on single, in the other $1\frac{3}{8}$ inches, — and the stirrup coming between the ends, gives it the advantage.

2. We can produce much more even yarn, and thereby obtain a greater breaking strength; the following sizes will show to what extent, on No. 45 warp yarn: —

Double.		*Single.*	
	Pounds.		Pounds.
Size, 42.55, . .	Break, 47	Size, 44.94, . .	Break, 44
38.45, . .	52	45.45, . .	47
40.40, . .	46	45.45, . .	44
37.73, . .	52	43.47, . .	47
Average, 39.78, . .	49.25	Average, 44.83, . .	45.50
Greatest variation, .	4.82	Greatest variation, .	1.98

On coarse yarn, such as No. 30 warp, there is not so much variation in number, and sometimes yarn spun on double-boss rolls would be equally as even as that spun on single; but the advantage in break still remains, as the following sizes will show: —

Double.		*Single.*	
	Pounds.		Pounds.
Size, 29.41, . .	Break, 67	Size, 29.41, . .	Break, 68
29.41, . .	71	30.07, . .	67
30.77, . .	66	29.63, . .	72
30.30, . .	63	29.41, . .	72
30.77, . .	69	28.99, . .	73
29.41, . .	67	28.99, . .	73
30.53, . .	66	30.30, . .	67
30.30, . .	67	29.63, . .	69
Average, 30.07 . .	67	Average, 29.63, . .	70.50

		Pounds.
Standard break for 29.63,		59.40
Standard break for 30.07,		58.66
Single-boss breaks above standard,	11.10	
Double-boss breaks above standard,	8.34	
Single-boss breaks above double,	2.76	
Greatest variation on single-boss,		1.31
Greatest variation on double-boss,		.89

It might be well to state that the difference in the average size is due to the fact that the frames were of different make, and could not be geared exactly alike.

I have given but two reasons why I prefer the single to the double boss roll, as time will not permit me to give more, although I could give a great many; but I want to say that we derive a greater advantage, the finer numbers we spin. On our No. 60 warp we obtain about ten per cent. advantage in break; and the numbers will not vary nearly as much, as the following sizes will show: —

Double.		*Single.*	
	Pounds.		Pounds.
Size, 57.97,	Break, 35	Size, 58.82,	Break, 38
56.34,	38	57.14,	39
57.14,	37	57.14,	42
58.82,	36	58.82,	40
58.82,	37	57.97,	38
57.14.	38	57.97,	39
57.14,	37	58.82,	40
55.55,	38	57.14,	40
Average, 57.14,	37	Average, 57.97,	39.50

		Pounds.
Standard break for 57.14,		30.80
Standard break for 57.97,		30.36
Single-boss breaks above standard,	9.14	
Double-boss breaks above standard,	6.20	
Single-boss breaks above double,	2.94	
Greatest variation on single-boss,		1.68
Greatest variation on double-boss,		3.27

I trust this subject will be fully discussed, as I consider it of very great importance to weaving or yarn mills on either fine or coarse work.

If any one desires to ask me any questions, I will ans
them to the best of my ability and knowledge.

Mr. PARKER. Mr. President, it did not appear in
KENT'S paper why the yarn made on the single-boss
was stronger than that made on the long-boss roll; neither c
he state whether his tests have been made with a shell rol
a solid roll. I imagine that the advantage which
would claim for a single-boss roll would be that he co
get a more even covering or a more level roll than it would
possible in covering the long-boss roll. I think we would
agree that Mr. KENT makes a pretty strong yarn, whether i
made upon the double-boss or not; and I should like to kn
why it can not be made as strong upon any roll.

Mr. WILLIAM J. KENT. In reply to Mr. PARKER, I will
that I am afraid I should have exhausted your patience if I l
gone into all the details; and I said, at the end of my paper
would answer any questions which might be asked. The gr
advantage is the difference in covering the rolls, and also
the weighting of the rolls. The double-boss roll requires
great deal more weighting, to produce the same effect that
single-boss roll would; and consequently we find the ligh
the weighting to do the work, the better the product.
regard to breaking the yarn, we cannot weave the goods
sell to Mr. Parker, unless we have that yarn.

Mr. PARKER. There is one question I intended to as
whether the record, which I suppose you keep at the mills, u
formly shows the results which you have just read; or wheth
these were special tests.

Mr. WILLIAM J. KENT. No, sir; this is the record kept rig
in the mill.

Mr. KILBURN suggested that Mr. KENT derived an adva
tage from specially selecting his cotton, to make the goods
referred to.

Mr. KENT said that he considered a careful selection of c
ton as of very great importance; that, while some claimed th
could not afford to make the best selection, at his mill they cou

not afford not to. Mr. KENT further stated, in reply to a question by Mr. REDFORD, that he got his cotton from Helena, Ark.

Mr. ROBERT REDFORD stated that, for making nice combed yarn, he thought it was better to have a single-boss roll; and have that as wide as possible; that they could get along with about 4½ pounds weight, and could make a very nice, even yarn. He said, There is no doubt at all, in my mind, about being able to make a better yarn with a short roll than you can with a long roll, because by that means you get over the inequalities in the covering.

QUESTION. With a short roll?

Mr. REDFORD. Yes; with a short roll.

QUESTION. But would you use the shell roll?

Mr. REDFORD. I should use the shell roll if running two ends to a boss; but with a short roll, and one end to a boss, a shell would not be necessary. The advantages of using single end boss-rolls are readily seen in making fine combed yarns, say from 40s upwards, on account of less surface contact with the bottom roll, but I would not recommend this roll for coarse carded yarns, on account of the difficulty in cleaning the rolls while the mule is in motion. In Oldham, for coarse yarns, they use, exclusively, rolls two and three ends to a boss; while in Bolton, where the product is principally fine combed yarns, they use, exclusively, single-boss rolls.

Mr. KNIGHT. I would like to ask the gentleman how it would spin; which would spin the better, the short-boss or long-boss roll.

Mr. REDFORD. Well, if you were going to run short stock, I should say put all the weight you can on the front roll, and very little on the middle roll, and all the weight you can on the back roll; and let it go at that.

Mr. KNIGHT. Which would spin better, the long-boss roll or the short-boss roll?

Mr. REDFORD. I cannot give you my experience on coarse yarn, because I have not tried it, but it would spin better for

fine combed yarn. You cannot make successfully any nu bers, we will say, over 40, on a double-boss roll; especial hosiery. Suppose you try to make hosiery on a double-bo roll, you will have some fabric come back once in a whil because it shows bad places in the fabric, through the ya being cut. That defect would be reduced very materially l using a single-boss roll. It would certainly spin a great de better.

Mr. J. K. Russell. Mr. President, I would like to say few words on this roll question. There are some points th have not been fully brought out, regarding the extra amount labor expended in the care of the short-boss roll over the lon boss.

It requires just double the amount of labor and time to pic and oil the same length frame of short-boss rolls that it does long-boss; besides, in oiling, there is twice the danger of gettin oil on the covering; which we all know is injurious to the worl Again, when we wish to scour or clean our steel rolls, or an accident happens whereby we have to remove the top roll we have just twice as many rolls, saddles and stirrups t remove and replace; which means not only an expenditure time and labor, but loss of production, as well. Then again, th short-boss roll, being lighter, is easier retarded in its motion b clogging; thereby injuring the work, and making waste; on of the many causes for clogging being the greater liability the roving running out to one side, on the short-boss roll.

Speaking from an overseer's stand-point, I should say th the short-boss roll would require, on the part of the fram tender, from four to six times the amount of labor to keep th part of the frame up to the same standard of cleanliness, th the long-boss would. I would further say that I have bee entirely successful in spinning all warp yarns below 30s on th long-boss roll, and still prefer it for those numbers.

The President. If there is no objection, we will now pr ceed to the sixth topic, "Tests of spindle oils." Mr. A. M Goodale of Waltham, Mass., will open the discussion.

Mr. A. M. Goodale. Mr. President and gentlemen, it was not possible, between the time this topic was assigned to me and this meeting, for me to make thorough tests of spindle oils, either in the number of oils that I wanted to test or in the length of time to be given to each oil, and I can give you to-day simply the first of my tests. I had commenced a little while before this topic was assigned to me to make some tests, and those tests were used as a check on the tests that I have made since; but, in order to get in the number of oils that I wanted, it was not possible for me to run over four days with any one oil, and that is not a fair test for an oil. There is no question about that. Each oil should have at least six days' test, and two weeks would be much better, and have from ten to fourteen readings between doffs. In that way, taking either one week or two weeks, we could arrive at a proper result. The oil changes from the first day through the test. Oil may start out well and come out at the end poor; or the reverse may be the case, and the oil improve with time. I have taken seven oils, which I have marked 1 to 7.

(Mr. Goodale then referred to the blackboard, upon which he had tabulated a portion of the results of his tests, as shown in the following tables.)

The tests have all been made on a Fales & Jenks frame, containing 160 McMullan spindles, spinning No. 30 yarn from double roving, under the ordinary conditions of a spinning room. I could not spare a frame to test the spindles only, and should not, had I been able to do so, as I consider that tests made under the ordinary conditions of spinning are preferable.

The frame had a geared end, size of cylinder $7\frac{1}{16}$ inches, single-boss top roll, $2\frac{1}{2}$ gauge, $1\frac{3}{4}$ ring, 6 traverse with separators. A measured quantity of oil was put in each spindle base, and a measured quantity to the frame. The oil remaining after the test was also measured, so that the percentage of oil used is given, as one of the factors in the table. After the test the oil was removed from the spindle base by a pump; the bolsters were cleaned with steam jet, and the

spindles wiped. From eleven to fourteen readings were made from the empty bobbin to the full bobbin; and the average of all the readings is given in the table. The Emerson Power Scale was used; the oil used on scale being same as used in testing. The same oil used in testing spindles was also used on top rolls.

The tests were all made by Mr. William G. Nichols, who has served his time in the shop, and also in the mill; and who is thoroughly capable of making the most accurate tests. The gravity used in the table, the flash point, the fire test and the cold test were made by Prof. L. M. Norton of the Institute of Technology, the cold test being the point at which the oil ceased to flow.

Details of Oil.

Number of Oil.	Name of Oil.	Seller of Oil.	Price, Cents.	Gravity, Beaumé.	Flash Point, Degrees.	Fire Test, Degrees.	Cold Test.	Stain.	Number of Weighings.
1	Fountain Spindle Oil, . .	Masury, Young & Co., . .	17	31.1	315	365	16	–	55
2	Rabbeth Spindle Oil, . .	E F. Houghton & Co., . .	14½	35.0	311	358	11	3	69
3	Sample No. 1, . . .	Central Oil and Supply Co,	15½	30.3	360	421	14	5	75
4	Sample No. 2, . . .	Central Oil and Supply Co.,	17¼	32.0	356	410	12	4	78
5	W. W. Spindle Oil, . .	Waite, Williams & Co.,	16¼	31.0	394	542	12	6	62
6	Special Imperial Spindle Oil,	F. L. Young & Co., . .	16¼	38.7	281	315	21	1	73
7	Velocité Spindle Oil, . .	Vacuum Oil Company, .	20¼	34.4	297	335	11	2	71

Average Results of Tests.

Number of Oil.	Name of Oil.	Seller of Oil.	Temp. Creel, Degrees.	Temp. Rail, Degrees.	Different Temp.	Oil Used. Per Cent.	Cylinder Revolutions per Minute.	Spindles, Revolutions per Minute.	Horse-power, Frame.	Spindles per Horse-power.
1	Fountain Spindle Oil, . .	Masury, Young & Co, . .	86.3	–	–	–	1,057	9,100	2.11	76.30
2	Rabbeth Spindle Oil, . .	E. F. Houghton & Co., .	84.9	91.8	6.9	48.2	1,061	9,100	1.87	85.76
3	Sample No. 1, . . .	Central Oil and Supply Co,	84.3	93.4	9.1	50.9	1,060	9,100	2.09	76.95
4	Sample No. 2, . . .	Central Oil and Supply Co.,	84.9	94.9	10.0	51.8	1,061	9,100	2.07	77.57
5	W. W. Spindle Oil, . .	Waite, Williams & Co., .	86.3	97.5	11.2	55.4	1,060	9,100	2.22	72.12
6	Special Imperial Spindle Oil,	F. L. Young & Co., . .	81.0	87.0	6.0	44.4	1,065	9,100	1.88	85.22
7	Velocité Spindle Oil, . .	Vacuum Oil Company, .	84.1	90.8	6.7	48.2	1,064	9,100	1.86	86.64

Gravity, flash, fire and cold tests by Prof L. M. Norton, Massachusetts Institute of Technology. Emerson power scale, Huddleston's thermometers, Rowes' hygrodeik. All data taken under full operation of spinning.

Note. — Spindle-revolutions per minute should be 9,100 plus or minus.

Mr. GOODALE then stated that he should continue these tests between now and the next meeting; and that it would take fully that length of time to test thoroughly all the oils that had been presented for testing; and that he should be very glad, if the Board of Government desired, to present these tests fully and completely, at the next meeting. He wished to emphasize the fact that it was not possible for him to do more than make a preliminary test for this meeting.

In response to a question, Mr. GOODALE stated that these tests were all made on the same frame, under the same conditions, as far as possible.

Mr. MESSENGER stated that in regard to the flash point of the velocité oil he had had five different chemical analyses made. The first one was made at the Institute; one test showed over 300. Another test was 297 or 298, and another one was 304. His experience was that the same oil, under flash tests, necessarily varies; but the result runs very close to 300, with the velocité oil.

Mr. PARKER then stated that the Board of Government had provided for the topical discussions for the present meeting, with some doubt as to just what the result would be; and there were several more topics aranged for than they were sure would be discussed. As the time for adjournment had now arrived, he moved that the topics remaining be carried over to the next meeting, including the one now under discussion, "Tests of spindle oils." The motion was seconded and adopted.

Mr. PARKER also moved that the Board of Government be authorized to lay an assessment on the members of the Association, not exceeding ten dollars each, to defray the expenses of the association for the ensuing year. The motion was seconded and adopted.

The SECRETARY called the attention of the Association to the fact that, in making up catalogues of the members, it was

often difficult to follow changes made in their place of residence; and requested members when they changed their residence to notify him, in order that the catalogue might be properly corrected.

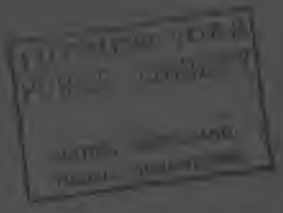
On motion it was voted that, when the Secretary makes out his next annual report, he should classify the members according to their States, and also print a list of the past officers of the Association.

Adjourned.

[No. 58.]

N. E. COTTON MANUFACTURERS' ASSOCIATION.

PROCEEDINGS



OF THE

SEMI-ANNUAL MEETING,

HELD AT BOSTON,

OCTOBER 26, 1892.

BOSTON:
WRIGHT & POTTER PRINTING CO.,
18 POST OFFICE SQUARE.
1892.

Cotton manf.

[No. 53.]

N. E. COTTON MANUFACTURERS' ASSOCIATION.

PROCEEDINGS

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OF THE

SEMI-ANNUAL MEETING,

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HELD AT BOSTON,

OCTOBER 26, 1892.

BOSTON:
WRIGHT & POTTER PRINTING CO.,
18 POST OFFICE SQUARE.
1892.

CALL FOR MEETING.

BOSTON, Oct. 1, 1892.

DEAR SIR: —

The stated semi-annual meeting of the Association will be held at the MASSACHUSETTS INSTITUTE OF TECHNOLOGY, *Boylston Street*, *Boston*, on

WEDNESDAY, OCTOBER 26, 1892, at ten o'clock A.M.

In the line of procedure adopted at the April meeting, the topics then announced for discussion, but postponed for lack of time, will be taken up for consideration, and be followed by others as indicated below; and subjects heretofore discussed will still be in order if called up by any member.

The list of topics thus assigned, and the names of members who will respectively introduce them, are as follows: —

1. Tests of spindle oils.

   Mr. A. M. GOODALE, Waltham, Mass.

2. The life of incandescent lamps.

   Mr. W. S. SOUTHWORTH, Lowell, Mass.

3. Picking, as applied to the English system of carding.

   Mr. ROBERT MCARTHUR, Biddeford, Me.

4. What is the best design for line shafting, transmitting over fifty horse-power, permitting stopping and starting on any floor without interfering with the motor or with other shafting?

   Mr. STEPHEN GREENE, Boston, Mass.

5. Can the dust room of the picker be done away with?

   Mr. JOHN W. WELLS, Woodbury, N. J.

6. Long-distance transmission of electricity; is it practicable for cotton-mill work?

Mr. C. J. H. Woodbury, Lynn, Mass.

7. (After-dinner topic.) The Vicars automatic stoker, and rope-driving; with other appliances noted in English cotton mills.

Mr. Edward Atkinson, Boston, Mass.

A large majority of the members having signified their approval of the suggestion of the Board of Government in circular issued June 27 last, a dinner will be provided for the Association at the close of the morning session. This will be paid for from the treasury, and will be free to all members.

By vote of the Board of Government,

AMBROSE EASTMAN,
Secretary.

PROCEEDINGS.

Pursuant to the foregoing notice, the stated semi-annual meeting of the Association was held at the Massachusetts Institute of Technology, Boylston Street, Boston, on Wednesday, Oct. 26, 1892, at 10 o'clock A.M.

The President, Mr. ROBERT McARTHUR, occupied the chair.

The President submitted the following nominations of new members, recommended by the Board of Government, for election: —

ELMER G. CHILDS,	Lowell, Mass.
J. WILLIAM CLARK,	Newark, N. J.
WILLIAM DOUGLASS,	Paterson, N. J.
JOHN M. DUNHAM,	Holyoke, Mass.
WILLIAM B. FITTZ,	West Boylston, Mass.
D. W. GRAY,	Forestdale, R. I.
W. E. KEACH,	Slatersville, R. I.
NATHANIEL B. KERR,	New Bedford, Mass.
JESSE A. KNIGHT,	Enfield, R. I.
J. COLBY LEWIS,	Centreville, R. I.
WILLIAM L. LYALL,	New York City.
IRA J. MARTIN,	Pawtucket, R. I.
JAMES I. MILLIKEN,	Lawrence, Mass.
ELLISON A. SMYTH,	Greenville, S
CHARLES A. SWEET,	North Scit
JAMES W. TAYLOR,	North
GEORGE W. TOWNE,	Law
J. C. WADLEIGH,	Lo
GEORGE F. WHITTEN,	M

On motion of Mr. W. J. KENT, it was voted that the Secretary be authorized to cast one vote for all the persons nominated. The vote was cast by the Secretary, and the persons above named were declared elected members of the Association.

The PRESIDENT. We will now proceed with the topics presented for discussion by this meeting. The first will be, "Tests of Spindle Oils," by Mr. A. M. GOODALE of Waltham, Mass.

TESTS OF SPINDLE OILS.

By Mr. A. M. Goodale, Waltham, Mass.

The topic of spindle oils, assigned to me for the last meeting of the Association, was treated in an imperfect manner, owing to the limited time at my disposal. In going into the subject carefully, I became convinced that it was necessary to give two weeks' time at least to each oil in order to get the best results. In this way each test is commenced Monday morning after the rest of Sunday, when the frame starts hard, and has to be gradually warmed up; and, as a check on the first week's run, a second week's test is given to the same oil under the same conditions. In this way the readings of the second week are a check on the readings of the first week, and a more accurate result is obtained than if only one week or a portion of a week were given to each test.

In comparing the table here presented with the table presented at the April meeting, certain things are to be noticed. First, the Fountain Spindle Oil in the April test was a heavy spindle oil of Masury, Young & Co. In the present table their light spindle oil is the one tested. The Velocité Spindle Oil in the second test is presumably of the same grade, though the oil in the second table was taken from a different barrel than that of the first test. The Special Imperial Oil of F. L. Young in the present test is an improved Special Imperial Oil sent after the first tests had been made and presented to you. The other oils presented in this table were not presented in the April table.

The gravity, flash test, fire test, cold test and viscosity were taken by Prof. L. M. Norton of the Institute of Technology. Weighings were taken, as before, by Wm. G. Nichols, assisted by H. P. Meikleham. The tests have all been made on a Fales & Jenks frame, containing 160 McMullan spindles, spinning No. 30 yarn from double roving, under the ordinary conditions of a spinning room. It was not convenient for me to test a frame with spindles only, and I do not consider that a test with spindles only is as desirable as a test made under the full conditions of spinning. The frame had a geared end, size of cylinder $7\frac{1}{16}$ inches, single boss top roll, $2\frac{1}{2}$ gauge, $1\frac{3}{4}$ ring, 6 inch traverse with separators. A measured quantity of oil was put in each spindle base, and the quantity to the frame accurately measured. The oil remaining after the test was also measured, so that the percentage of oil used is given as one of the factors in the table.

After each test the oil was removed from the spindle base by a pump. The bolsters were cleaned with a steam jet, and the spindles wiped. From 11 to 14 readings were made from the empty bobbin to the full bobbin, and an average of 188 weighings were taken for each oil. The average of all the readings is the average given in the table. The Emerson Power Scale was used, the oil used on the scale being the same in each test. The oil used in the spindles being too light for the other running parts, another oil was used for that purpose, being the same throughout all the tests of this series.

The tests of oils that have been made from time to time under the direction of the Cotton Manufacturers' Association have, without doubt, furnished valuable information both to the oil dealers and to the members of the Association. It is not very long ago that the first cost of an oil was an important factor with the manufacturers. To-day I do not suppose that one member of this Association regards the first cost of an oil to the mill as being of much importance. To illustrate: There are 20,000 ring spindles in the room where these tests were made, and, taking the percentage of the oil used of the best and of the poorest oil

in the April table, the difference in the first cost between the best and poorest oils therein mentioned for one year was $35, whereas the difference in the coal pile would have been $1,150 for the same oils. That is, it would have taken $1,150 worth more coal to have run that room for one year with the poorest oil than it would have with the best oil.

The tests of oils, under the direction of this Association, which were commenced some years ago, and which have been continued with more or less regularity until the present series, have been the means of providing the manufacturers with oils suited to the different uses of the mill. Spindle oil fit to use in a Rabbeth spindle is not fit to use in any other part of the mill, that I am aware of. The conditions for the use in the Rabbeth spindle render it unfit for any other use, and with the large proportion of Rabbeth spindles at present in use, and with the high speed of the present day, it is extremely necessary that the oil used for this purpose should be an oil best adapted for the same.

It gives me great satisfaction to note by this table that there are six oils presented which give good results. I should have been sorry if this series of tests had proven that any oil had been much the superior of all the others. The competition for the mill trade is very keen. The oil men are constantly striving to give us a better oil, and I find, between my first and second series of tests, oils for fast-running spindles were so improved, that, instead of three oils only giving fair results, as was the case in my first table, we have now six oils each giving better results than the best oil of the April table.

You are aware, of course, that these tests were made as near as possible from the regular grade of oils furnished by the maker to the mill, and you are also aware that the tests, as given, were made simply on the oils that were furnished to me. The tests were made with scrupulous care, and every detail attended to that would give an added value to the tests. But a test on a single frame is of slight value compared with an ideal test for oils. This, I take it, would be a spinning room so ar-

ranged that the power of the whole room could be noted, as is shown in these tables with one frame. Take a room with 160 spinning frames, for instance, containing Rabbeth spindles, and using in each for two weeks or longer each of the oils mentioned in this table, — the results would be far more valuable than the present ones.

To me these tests prove that, if a mill considers it desirable to make a yearly contract for oil, there are certain grades of oil that it is safe to contract for; and I then consider it absolutely necessary that a clause should be inserted in that contract, providing that the quality of the oil should be maintained at a certain agreed basis, and that tests should be made by the mill each month in the year, to determine if each shipment of oil is up to the standard. I know of no other way in which the mill can be sure of getting what it pays for. These tests are not difficult, they are not costly, and they are instructive. You lose no spinning. You simply pay for the services of the man making the tests, and this is so slight an amount, compared with the value of the check to the oil dealer, that it should not be taken into account.

Great care is necessary in making tests for oil on a single frame. The belt should always have an even tension, as the tare would be wrong if the belt slipped. The frame must be protected from drafts, and the sun must not be allowed to shine on the thermometers. There should be no binding of the quadrant, and an even bearing of the drawing studs. The readings should not include tests for parts of a doff. If these points are carefully attended to, and the readings taken always by the same person, the results obtained will be as good as can be obtained from a test of a single frame.

Tests of Spindle Oil.

Details of Oil.

No. of Oil.	Name of Oil.	Seller of Oil.	Cost (Cents).	Gravity at 60° Fahr. Beaumé.	Flash Point.	Fire Test.	Cold Test.	Viscosity.*
					Fahr.	Fahr.	Fahr.	
1	Fountain Spindle Oil, .	Masury, Young & Co., .	–	39	280	315	+24	0.632
2	Velocité Spindle Oil, . .	Vacuum Oil Company, .	–	34°	302	336	+5	0.665
3	Rabbeth Spindle Oil, .	Seccomb, Kehew & Sons, .	–	39	279	313	+24	0.630
4	Power-saving Spindle Oil,	Seccomb, Kehew & Sons, .	–	32°	387	426	+16	0.875
5	Economy Spindle Oil, .	Platt & Washburn Refining Company.	–	35°	304	333	+22	0.657
6	Special Imperial Spindle Oil.	Frank L. Young, . . .	–	38°	282	315	+22	0.650
7	X L Spindle Oil, . .	Waite, Williams & Co , .	–	35°	262	300	+18	0.670
8	Submerged Spindle Oil, .	A. W. Harris Oil Company,	–	32°	379	430	+26	0.902
9	Rapid Spindle Oil, . .	F. H. Little & Co , . .	–	34°	315	361	+17°	0.708

* Viscosity, sperm being 1.

Details of Tests.

No. of Oil.	Weighings.	Creel Temperature.	Rail Temperature.	Difference in Temperature.	Per Cent. Oil used.	Cylinder Revolutions per Minute.	Spindle Revolutions per Minute.	Horse-power Frame.	Spindles per Horse-power.
1	199	85.4	91.1	5.7	51.1	1,061	9,100	1.73	92.66
2	194	85.5	92.5	7.	47.8	1,056	9,100	1.94	82.99
3	184	91.1	96.4	5.3	47.	1,056	9,100	1.77	91.16
4	187	93.	102.8	9.8	45.4	1,056	9,100	2.06	78.
5	182	89.8	97.7	7.9	50.9	1,060	9,100	1.89	85.23
6	202	93.7	100.2	6.5	47.5	1,061	9,100	1.67	96.51
7	207	93.4	100.3	6.9	46.6	1,061	9,100	1.76	91.94
8	149	93.7	103.6	9.9	49.1	1,061	9,100	1.76	91.4
9	182	84.19	91.5	7.7	48.3	1,055	9,100	1.67	96.01

Emerson's Power Scale, Huddleston's Thermometers, Rowe's Hygrodeik. All data taken under full operation of spinning.
Note.—Spindle revolutions per minute should be 9,100 plus or minus.

The PRESIDENT. Gentlemen, the discussion of this subject is now in order, and I hope it will be taken up; as it is one of great importance.

Mr. GULLIVER. I should like to ask whether those tests were made from the time that the spindle starts, or the bobbin starts?

Mr. GOODALE. The tests were all taken on full doffs, from the time the bobbin starts. There is no part of a doff included in the table given.

Mr. KENT. I would like to have permission given to Mr. SMIDD to ask a question, if he desires to do so.

The PRESIDENT. Mr. SMIDD will have the privilege of ask ing a question.

Mr. SMIDD. The question I would like to ask is this: I do not see any record of the humidity of the atmosphere at the time the observations were taken. That enters largely into this matter. Was any such record taken when the tests were made?

Mr. GOODALE. That was taken as accurately as the other details, and I regret that when that table was put on the board it was omitted. It was taken in each case.

Mr. WOODBURY. In looking over the measurements of the gravity of these samples of oil, it will be seen that all of them are lighter than 32° Beaumé, and I believe that is one reason of the improvement in the ease of running. Thirteen years ago, when I was making some measurements of friction, an oil manufacturer made an oil of 32° gravity, and could not sell it, because people were afraid it would wear out the spindles; and the measurements all seem to show, here as well as elsewhere, that within a general limit there is some relation between the fluidity of the oil and its value as a lubricant, as far as its diminution of friction is concerned, although of course light oil will not adhere so firmly to the bearing surfaces as heavier oil, and a greater quantity is required. This matter of adhesion of oils to metal is a very important factor in lubrication, and not by any means wholly inconsistent with fluidity. A ve

fluid oil which adheres very firmly to the bearings makes the best lubricant, except in cases of very heavy pressures on the bearings, where the film of oil is too thin to keep the metal surfaces separated from each other. The peculiar adhesion of some kinds of oil to metals is well illustrated by lard oil adhering to the cutting edges of machine tools better than other oils. I presume in these experiments that the spindle band tensions were made constant; that Mr. GOODALE took all possible care that there should not be any variation in the spindle bands beyond what is inevitably due to change in the humidity of the air. I would like to ask if there was any change in the oil used in other parts of the spinning frames except the spindles.

Mr. GOODALE. The oil on other parts was kept constant, every care was taken with the bands, and the humidity was kept up.

A MEMBER. I would like to have Mr. GOODALE tell us how we are going to guard against variations in the quality of the oil. Every little while I find our machinery running hard, and that we lose more power on some days than on others, for which there is of course some reason. Although we buy our oil of the same brand, from the same parties, it seems to come to us of various qualities; and if there is any simple method which will guarantee us the same quality of oil continuously, I should like to know what it is. These tests convey a great deal of information as tests, but the next point is, how we are going to secure the same quality of oil.

Mr. GOODALE. I tried to cover that point in my paper by saying that I believe it is necessary in contracting for oil to have the contract contain a provision that each shipment of oil shall be up to a certain agreed standard; and I believe that each shipment received ought to be tested. The cost is very slight, and it would be of great value to the mill.

A MEMBER. How should we proceed to have our oil tested? When I tested oil fifteen or twenty years ago, I took a bottle of it to Brown University, Providence, but did not get a very satisfactory answer.

Mr. GOODALE. I don't know any better way than the way in which I made these tests. If I had known any better method, I should have adopted it. It is some little trouble, but it is well worth the amount it costs.

The PRESIDENT. If no one wishes to say anything more on this subject we will pass to the next topic, which is "The life of incandescent lamps," by Mr. W. S. SOUTHWORTH of Lowell, Mass.

THE LIFE OF INCANDESCENT LAMPS.

By Mr. W. S. Southworth, Lowell, Mass.

In speaking on the topic assigned me, I take it that I am expected to state only the results of my own rather limited experience.

We have at the Massachusetts Cotton Mills one Edison dynamo, of a maximum capacity of about 600 twenty-candle-power lamps, though but 510 lamps have been installed. This plant has been in use about five years, and the dynamo runs whenever the machinery does, as the mill in which it is located is so darkened by the proximity of other buildings that a considerable number of lamps is in use even at mid-day in summer.

The lamps used are the Edison. As many other people have done, we began with sixteen-candle-power lamps, but later concluded the twenty-candle-power were more satisfactory for use in our weaving rooms, where we have one lamp to four thirty-inch looms. We have from time to time used small lots of lamps of other makes, experimentally, but have as yet found no sufficient reason for making a change. Until within a year we have ordered lamps of one or two vólts above the rating of the dynamo, as a result of which my figures as to their average life are no doubt a little more favorable than they might otherwise have been.

I find that the average number of yearly renewals is 276. For one year I had an account kept of the number of lamps burning at different hours of the day, on pleasant and on cloudy

days, in each month; and I assume that the average so ascertained holds good for the other four years. The total number of lamp-hours for that year is 431,220. As an offset to the fact that the lamps now in use should be taken as about half burned out, I add 51 to the number of yearly renewals (that is, one-fifth of half the whole number in use), making 367; using this sum as a divisor gives 1,319 hours average life of a lamp. Examples of very long life of individual lamps are common. For instance, we have one in the office safe which at this time has been burning something more than 6,200 hours, and is still in fair condition.

The largest item in the cost of operating the plant is of course for power. I estimate the average requirement at twenty horse-power, which I put at $25 per annum, making $500. Of course you will understand that water power is relied upon for a considerable portion of the year. For depreciation and repairs I allow $250; for interest, $225; lamps, $110; and for oil, attendance, etc., $75; making a total of $1,160 a year. The cost of gas saved, at $1.10 per thousand feet, I find to be about $1,500. This would make the cost of the electric light equivalent to that of gas at eighty-five cents a thousand. I consider that it has certain advantages over gas which have a money value, though that value is difficult to estimate.

The PRESIDENT. You have heard the paper of Mr. SOUTHWORTH. If the members would like to enter into any discussion of that subject, I should be pleased to have them. I suppose gas would come into the discussion as well as electric lights.

Mr. BROWN. My experience with electric lights has been limited. We are running only 100. Mr. SOUTHWORTH mentioned an incident which recalled an experience of my own, and that is, that he commenced with sixteen-candle-power lamps, but soon got to using twenty-candle-power lamps. I would like to ask what the depreciation of the lamp is. The average life of an electric lamp, as I understand, is 1,000 hours. Now when that lamp is burned one-tenth of that time, is one-tenth of its light done away with? I think our lamps keep growing dimmer and dimmer, and I have sometimes taken them out before they were finished, because they were not giving light enough.

Mr. SOUTHWORTH. I think that is the common experience of everybody who uses incandescent lamps. Many people have come to me with lamps to be tested, claiming that they would not deteriorate or blacken. I have tried a good many experiments with them, and have not found that claim borne out. I should say that after a lamp had burned 500 hours not one-half of its value was gone; I don't think they deteriorate so rapidly as that. I rarely have any taken out; I think they generally burn until the lamp breaks, or until the lamp is smashed, perhaps intentionally, by the weaver.

A MEMBER. I should be pleased if some gentleman would tell us the comparative cost of the incandescent and the arc light.

The PRESIDENT. Perhaps Mr. WOODBURY can give us some light on that point.

Mr. WOODBURY. I don't know as I can answer that, because the arc light is so peculiar in its requirements. I suppose, for instance, that in the position in which they would be applied in an iron foundry incandescent lights would be almost worthless,

while the arc light is very valuable. In weaving mills of over thirteen feet stud, used for manufacturing colored goods, half-arc lights of 1,200 candle-power are generally used; and under such circumstances the arc light is considered more advantageous than the incandescent light. In illumination for such inside work in weaving mills, the half-arc lights will go just as far as the full 2,000 candle-power arc lights, on account of the necessity of a certain number of lights to do away with shadows, and are more agreeable to the eyes of the weavers. As I remember the figures, some persons illuminate as many as thirty-six looms to one arc light. If the room is not high enough, it will require a larger number of arc lights for illumination. For a 1,200 candle-power light it would require about five-eighths of a horse-power at the dynamo for each light, perhaps a little less. In most instances incandescent lights are preferable to arc lights in textile mills.

The PRESIDENT. I notice that Mr. SOUTHWORTH states quite a difference in the cost of gas and electricity. I would like to ask him if he would recommend any one who has a gas plant to abandon it and put electricity into his mill?

Mr. SOUTHWORTH. Speaking for myself, I should say, if the Massachusetts Company could afford it, I should be glad to supersede all my gas lights by electric lamps, and I think it would be profitable.

The PRESIDENT. That does not exactly answer the question, which was, if you had a gas plant, would you abandon that plant and put in electricity?

Mr. SOUTHWORTH. I beg pardon for having misunderstood the question. I know nothing whatever about the operation of a gas plant or the cost of gas so obtained; so that, looking at the matter from the stand-point of cost only, I really could not give an intelligent reply. From some figures just given me by Mr. WEEKS as to the cost of his gas, I should judge it was far cheaper to use gas than electric lights; supposing the plant already established.

The PRESIDENT. I should agree with that statement, and

should say that, if any one has already a gas plant in, it would be cheaper to continue the use of it than to supplant it by electric light. Whether it is better or not is another question.

We will pass on to the next topic, which is "Picking, as applied to the English system of carding." That subject is not one of my choice. It has been assigned to me, and I have consented to present it.

PICKING, AS APPLIED TO THE ENGLISH SYSTEM OF CARDING.

By Mr. Robert McArthur, Biddeford, Me.

The preliminary notice of our last meeting, which was sent to each member of this Association, intimates that it is desirable that those who have been assigned the introduction of subjects will open them briefly. Since there are a large number of topics arranged for this meeting, it is almost imperative that they should be presented in as concise a manner as possible, otherwise there would be little or no time left for discussion.

As the picking department is the starting-point toward the product of our looms, it follows that, in order to have our mills produce good work, we must commence right. Sometimes we begin right and come out wrong; but we can't very well start wrong and come out right.

With the American system of double carding, we have always considered an even lap not only desirable but very essential for the production of even yarn. Now, if an even and otherwise good lap is essential in double carding, surely it must be much more so to the manufacturers who have adopted the English system of single carding. It is quite evident to all these that they must have an even lap, for without this important factor it is next to impossible to produce good work.

Before going further, I wish to say that I have no dispo tion to find fault with the builders of picking machinery; the contrary, I believe they deserve much credit for the m

valuable improvements that have been applied to their machines during the past thirty years. This is evident from the fact that we can produce more and of better quality with the common card now than we could thirty years ago, when we ran our mills twenty per cent. longer, or two hours a day more than we do at the present time. This is not due to the improvements on the common card. I claim that, while the picker builders have advanced, the builders of the common card have stood comparatively still; that is, so far as the quantity and quality of work produced is concerned. But, notwithstanding the improvements that have been made in picking machinery, I believe the requirements of the English system of single carding will stimulate the builders to produce something better.

I shall not attempt to describe all of the many different systems of picking, as only a few of them are pertinent to this subject. Our main object should be to ascertain the best method of producing a well-picked, clean and even lap. We know that this cannot be done by crowding a large amount of cotton through a double or triple beater opener, making a heavy, badly picked and uneven lap; neither can we remedy this evil by passing it through the next process, say two double-beater finishers. I contend that we ought to have as many openers as we have finishers. It is a common practice among mill managers in this country, and as I understand in England also, to have from fifty to twenty-five per cent. less breaker or opener machines than of finishers, which I believe is wrong.

The ideal system is, in my opinion, to have four processes of single-beater machines, and an equal number of machines, in each process; openers with the automatic feeders attached, and double four laps on each of the other three processes, making about a twelve-ounce lap all through.

Objections to this system may be raised on account of the extra cost of machinery, labor of tending and floor space. A more feasible plan is to have a double-beater opener with the automatic feeder, followed by single beater, intermediate and finisher, doubling four laps on each of the two latter. In case

the room will not admit of placing the machines required on one floor, the opener can be divided by locating the first section on the floor above or below, wherever it is most convenient to open the cotton, the connection with the lap-head section being made by the trunk system, which may be applied either inclined, horizontal or vertical. With a connection of this kind, the lap-head section should have a gauge-box attachment, to ensure an even feed, otherwise the laps will be irregular.

In regard to the trunk system, I have little to say in its favor. If the opening machine must be divided, it answers very well as a connecting link; but it is much more satisfactory to have all the machines on one floor, and dispense with the trunks.

In conclusion, I would say that the proper mixing of the cotton, the speed of the beaters and fans, the adjustment of the feed rolls, and ample ventilation of the dust room, are matters of great importance, and should have careful attention.

Mr. W. J. Kent. I should like to ask what objection you have to the trunks?

The President. The principal objection I have is to the first cost, and the cost of tending and cleaning. I contend that what dust we gather in the trunks, if we didn't have them, would go into the dust room. The trunks are put on the first section, and of course they gather a great deal of dust, and some bolls, sand, etc.; but if they were put on the last section, on the finisher, you would find it altogether different.

Mr. E. A. Leigh. Mr. President, it will perhaps be of interest to the meeting if I give a short account of the best English system of picking. As many of you are aware, the bale breaker is now universally adopted in all modern mills in England, both for coarse and fine work. The object is to pull the cotton into small pieces, the matted pieces thus being opened out and the dirt exposed. The cotton is delivered from the bale breaker by lattices to the different mixings, and for fine work should stand in the mixing at least a week—longer, if possible. Should the cotton be of a leafy nature, the room should be heated artificially, so that each fibre becomes of the same temperature. Another reason is, that when cotton containing leaf is subjected to a little heat the leaf rolls up and becomes crisp, and can be got out by the heater without being broken up. If the cotton contains seeds, heat causes trouble, as the cotton clings to the seeds. By allowing the cotton to lie in an open state in the mixing a few days, the dirt being more exposed and the fibres of an even temperature, we can treat it less harshly in the opening and scutching, by running the beaters slower, and do not knock the nature out of the staple, thereby making stronger yarn.

The patent exhaust opener is also almost universally adopted for coarse and medium counts in modern mills in England, and for fine work it is gradually superseding the opener with one porcupine cylinder and one beater, which does its work well, but is of small production, say about eight thousand pounds per week of good work; whereas the exhaust opener will do

really good work on the finest counts at twenty-five thousand pounds per week, making a thirty-seven to a forty-pound lap on a forty-one-inch wide machine in about four minutes. The exhaust opener is followed by two single-breaker and two single-finisher lap machines for ordinary American cotton, and by three single-beater finishers only for the highest grade of American and Egyptian cottons.

For example, take an Oldham mill of ninety-five thousand mule spindles for a calculated production of about fifty-four thousand pounds of average thirty-four twist and fifty-five filling per week from American cotton. There would be one bale breaker, which delivers by lattices to six mixings; two lattice feeders in the same room feed two exhaust openers in the room below. To the lattice feeders are attached breaker rollers, which give the cotton another pulling, and a small cylinder which gives a good amount of cleaning with very little punishment. The cotton then passes over a set of patent dust trunks, with a grid travelling slowly in the opposite direction which collects a great deal of seed and leaf, and empties the dirt automatically into a bag at either end, thus keeping the room free from dust, the cotton being then drawn onto the exhaust openers. The two exhaust openers make laps for five single-beater intermediate and five single-beater finisher lappers, each four laps into one.

Again, take a Bolton mill, containing sixty-five thousand mule spindles, producing say twenty-four thousand pounds per week of average sixty twist from Egyptian cotton. There would be one bale breaker, delivering to three mixings, one patent exhaust opener, with lattice feeder in mixing room, making say an eleven-ounce lap, and which would feed three single-finisher lap machines, making forty-inch laps of nine and one-half ounces to the yard.

It will be seen from what I have said that on the Engl system fewer machines are used and the cotton is not so sev handled, although the maximum of cleaning is obtained w less stringy and more even lap.

Mr. BROWN. I would like to ask the gentleman what machine it was that put through 25,000 pounds a week?

Mr. LEIGH. An exhaust opener.

Mr. BROWN. Not having much experience with English cards, I don't know that I can discuss the question at all. We have one card only; that is working well. I think you said picking should have a gauge box. Allow me to ask why, and why should the system of picking for English, be different from that for American carding? Turning back to the history of picking, from the Whitin picker to the present day, it seems to me there has been little or no change. We have the same murderous machine we have always had, except for the improved methods of taking the air away and introducing air, and the evening of the lap. If there has been anything else, I wish some one would tell us would tell us what it is.

The PRESIDENT. In regard to the gauge box, I have had considerable experience with the trunk system with the gauge box attached, and also without any gauge box. For instance, when you stop the machine, if you do not have a gauge box there will be quite an accumulation of cotton next to the screens when it starts, and then you have a very heavy, thick place; and without the gauge box the feed is more irregular, it strikes the screens in large and small pieces, at irregular intervals; but where there is a gauge box it ensures an even feed. There is always supposed to be cotton in the gauge box, from one-third to two-thirds full, and sometimes full and running over. Our tests that we have made have proved that we could make a much more even lap with the gauge box than without.

Mr. BROWN. Have you tried a machine with an evener, without a gauge box?

The PRESIDENT. I think that has been tried. I should prefer to have a gauge box; in fact, I wouldn't have a trunk without one, if I could avoid it.

Mr. W. J. KENT. I would like to ask Mr. PERHAM to defend his trunk system, and answer Mr. BROWN's question.

Mr. PERHAM. I did not intend to discuss this question; but, in answer to Mr. BROWN, will say that we deal in both the gauge-box system and the screen-section system; it is immaterial which we furnish the customer. With a gauge box on the breaker you get an even feed. Referring to the latter part of the President's paper in regard to the trunk, I differ from him on that point. I think in the use of a low-grade cotton that trunks are very necessary, placed between the opener and other distant parts of the machine, for making the lap. All the heavy dirt taken out by the trunk saves so much in subsequent cleaning; and I believe it takes out a great deal that would go to the card. I would like to hear from someone in relation to trunks.

Mr. MOORE. I should like to ask Mr. LEIGH if in the English mills they use a breaker with the exhaust trunk.

Mr. JOHNSTON. What they call a bale breaker?

Mr. MOORE. Yes, sir.

Mr. JOHNSTON. As to the necessity for a bale breaker, where you have a self-feeder, if the bale breaker does not meet all the requirements, the self-feeder would save the extra handling of stock. In relation to trunks, I would say, with reference to what our President said about the piling up of the cotton where you stop your feed; that is avoided where you have the self-acting valve; and when the feed stops, the valve is closed at the opener cylinder, and the draft immediately stopped, and whatever cotton is in the trunk drops at that spot, going on again when the feeder is started. In this way you avoid one difficulty that has existed in relation to trunks. There are evils connected with the use of trunks; with the old construction there were great evils. It is like the old licker-in, having inherent defects. The point is the cleaning of the cotton, and how we can clean it best without detriment to it. You take the trunk, and you get out a certain amount of heavy dirt that it seems you cannot get out well in any other way; but yet there are inherent defects in relation to currents of air, especially on a wide trunk, where the currents do not carry

so strong at the outer edges, and the cotton is held back, the other passes it, it gets twisted up, and you cannot then get the dirt out, or straighten the cotton out, after it gets to the card under these conditions.

Mr. LEIGH. The object is to open the cotton properly, and the English machine secures this. The purpose of the bale breaker is to have the cotton pulled properly apart, and get it perfectly dry. The automatic feed opens it still further, and is a great saving of labor in tending a number of machines.

Mr. BOURNE. After going through the bale breaker, how long before the cotton is used?

Mr. LEIGH. They let it lie as long as they can, three days or a week if they have the room, and in some places even longer for fine work, so that when the cotton goes to the opener, the dirt being exposed can be got out without running the beaters at an excessive speed.

Mr. BROWN. As to the bale breaker, I should judge that there are not many used in this country. Two or three years ago a party recommended a bale breaker to me very highly, and told me I could put a bale of cotton through in five minutes. I told him if I could get it through in five minutes I would be glad to have it. I succeeded in getting a bale through in ten minutes. The builder said "speed it." I speeded it, and it went to pieces. I have never started it since.

Mr. KNIGHT. Mr. LEIGH spoke of an important matter, something which we do not perhaps give enough of attention to in this country, and that was the ageing of cotton. My friend Mr. BOURNE has an arrangement that I have been considerably interested in, and, as he is naturally modest, I will give you a description of it. He has in the bay back of the machine a bin, which is perhaps thirty or forty feet away. This bin or enclosure I should say is about eight or nine feet wide at the bottom, and somewhat narrower at the top, and at the bottom are planks laid across on a track, so they can be pried forward as the bin is filled. The bin is seven or eight feet long and perhaps seven feet high; and, being narrower at

the top, it permits the cotton to stand all right after it is pushed out of the bin. The cotton is piled up on the back side of this arrangement, and the man who opens the cotton keeps this full all the time, so that the man who is feeding is not using cotton last opened, but is using cotton that has been opened the longest. This accomplishes two purposes: it gives the cotton a chance to dry, and, as Mr. LEIGH said, to become of the same temperature, and does away with the nuisance of calling in everybody to open cotton and interfere with the shipping of goods, etc., one or two days in the week. It places the duty of opening the cotton on one or two men. I think it is a very good arrangement. There is another advantage, and that is, that the cotton is always close by the man who is feeding on the apron. As he uses the cotton up more is pried forward, and the empty planks are carried back and filled again. Mr. BOURNE has a man who feeds one hundred and fifty thousand pounds of cotton a week. I have a man feeding one hundred thousand pounds, and he thinks he has all he can attend to.

The PRESIDENT. The question has been asked why it was more essential to have an evener lap for single than double cards. With an English card we have less doublings, and of course the evener we start the more likely we are to make an even thread.

Mr. BROWN. The same thing is true of the American card.

The PRESIDENT. I do not deny that. I said in my paper that it was essential to have an even lap for American cards, but I think it is more essential to have it for the single English card system.

Mr. W. J. KENT. Why doesn't Mr. ATHERTON put a gauge box on his system?

Mr. ATHERTON. I have never seen the necessity for that. I have never used a gauge box. I have been making pickers for twenty-three years, and have never seen the necessity for it, judging from the expression of our customers. It may be a necessity with some machines, but has never been with ours.

The PRESIDENT. I would like to ask Mr. JOHNSTON what

he thinks about trunks; would he apply them if he had his picking system all on one floor?

Mr. JOHNSTON. I don't know as it is easy to answer that question. I think, considering the changes made in lappers and the advantages claimed for each kind, that, if I were going to build a picking room to-day, I should want to look round before I decided that. I have three picking rooms where the systems are all on one floor and where I have trunks, and two picking rooms where I have no trunks. I think the picking system that I have is doing as well as any other system. At the same time, the dirt that is got out in my trunks seems to prove the advantages of the trunk system over the system without it.

Mr. KNIGHT. I am a sort of neutral man on the trunk and gauge-box question; but it seems to me that the gauge box, if you have a trunk, is quite an advantage. Those who have the self feeder have noticed that in some places the cotton gathers in large bunches and in other places the teeth are bare. It seems to me that this trouble is somewhat neutralized by the gauge box, and therefore I am in favor of it.

Mr. PERHAM. I would like to say another word in regard to the trunk system. It has been said that the cleaning of the trunk from refuse collected, is an objection to it. To-day trunks are built with an exhaust arrangement for cleaning which does away with that difficulty.

A MEMBER. I will say, in reply to Mr. BROWN's statement, that there is no trouble in putting through a bale in five minutes. I have run bale breakers for several years.

The PRESIDENT. We will now pass to the next topic, "What is the best design for line shafting, transmitting over fifty horse-power, permitting stopping and starting on any floor without interfering with the motor or with other shafting?" by Mr. STEPHEN GREENE of Boston, Mass.

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Mr. GREENE. I wish to say, in the beginning, that I would like to alter the wording of the topic. It would seem to border on presumption for me to say anything on the topic worded exactly as it is. I don't like to speak about the *best* design for transmitting power; I would prefer to call the topic *a* design, not the best. I have thought also it would please the members of the Association better for me to say what I have to say, and present a sketch of what I would illustrate, rather than read a paper. So I shall present this drawing, which is prepared for the actual case of a mill transmitting about one thousand horse-power, and present it as an illustration of transmitting the power into various rooms.

On this drawing the right-hand sketch represents a transverse section through a rope tower, showing the transmission of power from the main fly-wheel of the engine to the head lines of the main shafts in the various rooms. These head shafts are carried on steel beams which are built into the brickwork of the belt tower, and shown by longitudinal section. This longitudinal section gives the position of the shafts with relation to these beams. The shafts are carried by pillow-block bearings, and extend through thimbles in the wall into the main room. There is no great improvement in that over what is employed in any of our first-class mills.

The simple device I suggest is to place on the shaft, just outside the rope tower wall in the main room, a friction cut-off coupling. I do not propose to discuss the merits of the various kinds of friction cut-off couplings. I suppose all of you have any number of circulars setting forth the merits of these various couplings; but any good friction cut-off coupling can be placed in the main line of shafting, with a lever extending down within reach, possibly not of a man standing on the floor, but by going up a few steps it could be reached. Then, having that so arranged, it could be operated in stopping or starting the shafting in each room. This could be applied at any of the other lines of shafting.

I don't think it wise to enter into a discussion of the question of electric transmission, or having an individual motor placed on any line of shafting.

In this drawing the rope drive shown was arranged for a possible extension of the mill. The drive shown to the right is the one first used. The belt tower, in the event of an extension of the mill, is large enough, and space in the engine room is provided for another tandem compound engine.

If there are any questions which I can answer, I should be very glad to do so.

The PRESIDENT. You have heard the remarks of Mr. GREENE. You will now have an opportunity to ask him any questions, or discuss the subject in any way you choose.

Mr. BOURNE. I would like to ask what system of rope driving he finds to be the best.

Mr. GREENE. In any case where the power is considerable, anything above a hundred horse-power, I have found the English system, the individual ropes, altogether better.

The PRESIDENT. I have no doubt that some of the members present have had something to do with the rope-driving system, and we should be pleased to hear from them.

Mr. RUSSELL. What is the life of a rope in comparison with the life of a belt, in a drive of that style?

Mr. GREENE. I don't know that anybody is able to answer that question definitely. Ropes have not been used in this country long enough, and there are no such conditions as would warrant an accurate answer. If I were to give an opinion, I should say that the life of a manila rope, under good conditions, would range from five to seven years. A good belt, if there is put on the amount of leather there ought to be, should have a life of at least twenty years.

The PRESIDENT. We have had them run thirty-nine years or more, and they are in good condition now. I would like to inquire of Mr. LEIGH if he is conversant with the rope drive.

Mr. LEIGH. In England many have gone into rope driving, and it is very popular; but personally I fail to see where the advantage is, except in the first cost. Every few years one or two ropes have to be replaced; whereas a belt, if properly applied, will last for thirty or forty years. I think there is more loss of power on the rope than on the belt system.

Mr. KNIGHT. What is the relative economy, as far as power is concerned, between the belt and rope systems?

Mr. GREENE. As far as I know, there are no tests which will settle conclusively that question. I can conceive of a rope drive being run where the showing as regards power might be erroneous; but it makes all the difference in the world what the design of the groove is, and the relation of the rope to the groove. I did not intend to spring the question of rope driving on this body, and I want to be explicit on that point. I confined myself to the question I was asked to discuss, and I simply used that drawing in which ropes were used to illustrate my remarks. I am not here to apologise for the rope system. I might say that I have no reason to change the opinion I formed two or three years ago, — that, for a large amount of power, anything over five or six hundred horse-power, or where the power is concentrated and needs to be taken off to various head shafts in the mill, I know of no way the problem can be solved so satisfactorily as by the rope drive.

Mr. HERVEY KENT. In regard to rope driving, we have been taking some two hundred horse-power from one wheel with five ropes, between three or four years, and so far it has given us no trouble. We have had nothing to do since we put them on. It is necessary to be a little careful in starting up; we start that wheel a little before the others, so as not to throw the leading on the other side, and unless you have plenty of room you may have trouble in that direction. Then again, I think it cost eighty-one dollars for the ropes, while the cost of a belt would be three or four times that. So, on the score of first cost, the ropes are much cheaper.

Mr. JOHNSTON. How much less do the pulleys cost?

Mr. HERVEY KENT. Very much less; they are m lighter.

Mr. JOHNSTON. It depends on what rope you use.

Mr. HERVEY KENT. We use manila rope. Of course grooves have something to do with it. I do not see why t may not go another year as well as they do now.

Mr. GREENE. With reference to the matter of trouble care, in order that my position may not be misunderstood will mention one or two instances that came within my obser tion: Two years ago last June a mill requiring one thous or twelve hundred horse-power was started with rope tra mission, which I designed; there were twenty-seven one three-quarter inch ropes. In May this year the ropes had b run twenty-three months. Three had never been touched; others had been taken up once. There was considerable sl in those three ropes, and it was expected that in two or th months they would have to be taken up. I have not heard a belt that has been on that time that would not have to taken up. But for the ropes to do good service they m have room; you cannot draw them tightly and keep taki them up without their giving out. Unless the conditions a all right for good running, I would advise letting the ro drive alone and take the belt drive.

Mr. BIRKENHEAD. My experience of transmitting pow by means of a round band or rope is, that it has never bee looked upon in as favorable a light as it otherwise would hav been, for this reason; you will find in very many cases whe the attempt is made to transmit power from one part of machine to another with a round belt, or band, the maker o the machine put a groove in his pulleys unsuited for friction contact. Where positive drive is necessary, you will ofte find the groove that is to receive the band on an angle of ninet degrees, or square; now there is no more frictional contact i this case than there would be if the band lay on a flat surfac

like the flat face of a pulley. What is needed is an angle of from forty to forty-five degrees; you then have a positive drive groove. It has long been my opinion that the expensive and cumbersome belt will have to take a back seat.

The PRESIDENT. We will now take up the next topic, "Can the dust room of the picker be done away with?" by Mr. JOHN W. WELLS * of Woodbury, N. J.

Mr. WELLS. In many picker plants the dust room would be available for holding machinery, provided by some means the dust could be taken care of. The value of such space is a good measure of the outlay which can be afforded to replace the dust room.

In handling sawdust and some fibrous substances, and in taking shavings away from planers, there is provided a dust separator. The Arlington & Curtis Company, East Saginaw, Mich., build them, and hold the patents on them. To simply describe it, it is a truncated cone of proper proportions, into which fans can discharge. Any fan discharging into the atmosphere distributes its dust and fibre in all directions. The dust room simply limits the area in which that dust is spread, and the chimney takes away the air and some of the dust. A separator limits still further the dust and fibre carried out by the fan. It also changes the directions of the air currents from straight lines to circular.

It was originally called the cyclone dust separator, as it creates a mimic cyclone within its walls. A centrifugal motion is imparted to the dust, which is blown from the dust pipe as soon as it arrives in the separator. The lint and heavy dust is carried round on the walls of the separator, and gradually falls down to the apex of the cone, and as soon as it drops out of the current of air it will drop into a bag or a proper receptacle.

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* The Secretary minutes here, with great regret, the sudden death of Mr. WELLS, by accident, while in the discharge of his duties, which occurred Nov. 9, 1892. His remarks therefore appear without revision.

The simplest arrangement would be to place the pipe on the wall, and put on the separator as near as you can; but in two-story or higher buildings it will be necessary to carry the discharge pipe above the roof, to prevent covering the buildings with dust. Another and simpler way is to carry the separator itself on top of the roof. The separator can be adjusted so as to deposit its products in any convenient place, or carried to any part of the building where the waste cleaning is to be done. If that is not done, it should be carried to the top of the roof. The economy in its use is in the economy of space, and in saving as much of the dust as possible before it reaches the dust room. If it goes into this room the product is of little or no use, as it is mixed with other dust; whereas, from a separator where there were seven fans, I have collected in one day as much as four pounds of lint which required little or no cleaning, most of the heavy dust having gone up the chimney of the separator. There might be some other cleaning done after the matter leaves the separator, by passing over some trunk arrangement; but probably it would be better to take all to waste-cleaning machines.

I don't think that anybody who has a first-class dust room, with plenty of space for everything, will bother about separators unless the room is valuable. I can only speak of the small plant which I have been running for some two or three months without a dust room, and I think the results have been better than with a dust room. At our other mill our dust room is of ample size. It is no gain to use a separator, unless one prefers it, in such a case, and prefers to pay for it.

As to the price, if you put only one separator to each machine the price will be quite large, say $125 or $140 for a two-beater picker; but as the size of the separator increases the price is proportionately lessened; for six or eight fans I think $250 would cover the expense of the separator.

This method has been used by woollen mills to a considerable extent. In John Bromley's mill a fan takes dust from several pickers into one separator. This dust separator took the place

of a large dust room which did not keep the dust from the outside buildings. This separator was very satisfactory; it is used in other places in Philadelphia.

The PRESIDENT. You have heard the remarks of Mr. WELLS. I think this is quite an important subject, and from his statements it would appear that it would be cheaper to adopt this system than to go to the expense of building dust rooms and chimneys. There are some members of the Association who have adopted the system and know something about it, and perhaps they will give us some light on the subject.

Mr. WELLS. I omitted to say that a special use of it is where a Robinson trunk is used, thus cleaning directly into the separator rather than into the dust room. The clean fibre in the trunks is saved, or some of it, and can go back into good work. I am running one cloth shear, into a separator six feet high by three feet, which takes the place of a dust room ten by fifteen feet in the basement. It formerly discharged into the wheel pit. This makes a clean arrangement, and there is no danger of fire.

The PRESIDENT. I presume that the dust chimneys that are now in use could be utilized in placing the separators.

Mr. WELLS. I suppose they might, but it would be hardly worth while, because the dust separator, if set in the roof, needs no chimney except what goes with it. If it is set outside the building it would be easier to carry it up in a separate pipe.

Mr. BOURNE. I don't know that I can add anything to what Mr. WELLS has said. I have been experimenting with it for the past three or four months. I was in hopes to have had one on long enough to try it thoroughly and see what it would accomplish before this meeting took place. I have one story of the building that I now use for a dust room, which I need for machinery; and I think I am going to be able to make that arrangement by using this device. It is wonderful how it separates the lint from the dust, the lint falling one way and the dust going off

another. I have two separators hitched onto one system of dust flues that take the dust from eight fans, from the breaker and two finishers, and they work very satisfactorily. I tried to do with one, but could not make it work. You must have it big enough so that it will take care of the fans, not blow back. By putting two separators together, they will take eight fans. The agent sent me another one big enough to take care of eight fans, which I am going to put on top of the mill. It only arrived there this morning, so I didn't have time to put it up; but I have no doubt it will do its work. I think where one has a dust room which he wants to use for some other purpose this method will enable him to do so.

The PRESIDENT. You will abandon your dust chimney?

Mr. BOURNE. Yes, sir; because the dust chimney is not big enough. The separator recently sent me is about eight feet in diameter. I have one dust chimney now, but you could not put many separators in it; I shall have twelve separators. The waste will drop down into the room, where we bale it up.

The PRESIDENT. Will you have twelve pipes?

Mr. BOURNE. Yes, sir.

The PRESIDENT. Of what diameter?

Mr. BOURNE. About twenty-four inches.

The PRESIDENT. They go through the rooms?

Mr. BOURNE. Yes, sir.

The PRESIDENT. I should think that would be quite an obstruction.

Mr. BOURNE. It is; but it is the best I can do.

Mr. JOHNSTON. Would you recommend dispensing with dust rooms where you already have them, and where you do not need the room for something else, and put in this arrangement?

Mr. BOURNE. I don't know as I should want to advise that to-day. The insurance men are very quiet about it.

Mr. JOHNSTON. Is there a fan connected with it?

Mr. BOURNE. Only the fan of the picker.

Mr. JOHNSTON. Do you have less dust go through these connections than through the dust chimney?

Mr. KNIGHT. Mr. BOURNE's mill is about one hundred feet from my office, and my friends may have noticed some peculiar hieroglyphics in my letters, caused by little bunches of cotton dust flying about and into my ink. I expect when Mr. BOURNE gets in all his separators I shall be able to write with a plain pen without a wad of cotton dust attached to it.

Mr. ATKINSON. If theories come true in about the time they are usually supposed to, say in ten years, I will mention that some eight or ten years ago I called your attention to this cyclone dust collector, by which the chief hazard in a flour mill, which had rendered them explosive, had been removed. I have believed since then that after the first man put it into a cotton mill to take away the dust from his pickers, all the others would follow suit, — not because the insurance men recommend it, but because it would be profitable and safe.

Mr. WELLS. Soon after putting on the attachment to our pickers a picker caught fire, and the fire rolled round inside the cylinder; that was all.

Mr. BARKER. Who makes these separators?

Mr. WELLS. The Arlington & Curtis Company of East Saginaw, Mich.

The PRESIDENT. Before introducing the last topic assigned for this session, I take occasion to say that at its close we shall adjourn to the Thorndike House, where a dinner has been provided for the members present, tickets for which will be issued as we pass out. Before we go, Mr. ATKINSON will have some pictures from lantern slides exhibited, showing some features of the subject which he will present after dinner. Before the adjournment Mr. THOMPSON would like to say a few words in regard to a covering for cotton bales.

We will now take up the next topic, "Electrical transmissio of power for cotton mills," by C. J. H. WOODBURY, Lyn Mass.

ELECTRICAL TRANSMISSION OF POWER FOR COTTON MILLS.

By Mr. C. J. H. Woodbury, Lynn, Mass.

Every one of the numerous applications of electricity, excepting incandescent lighting and chemical processes, as electroplating, requires the use of electric motors; and some types of dynamos used for incandescent electric lighting contain a regulator which is operated by a motor.

The telegraph receiver is a motor in which the electric impulses produced by the work at the operator's hands at the sending key converts the electricity from the batteries into work. In like manner, electric bells, watchmen's record clocks, railway signals, fire alarms, and even telephones, all are examples of motors. Mr. Edison once exhibited to me a telephone in which a small rod attached to the diaphragm of the receiving telephone was fitted with mechanism by which its rapid longitudinal vibration was converted into circular motion, causing a tiny wheel to revolve very rapidly.

The experiments of Barlow in 1826, by which an electromagnet was used to cause a continuous revolution, gave rise to many ingenious inventions of devices for producing rotary motions by electricity; some of the experiments being on a large scale, so extensive, indeed, that a yacht was propelled by one fifty-four years ago, and a railway car forty-one years ago. All of these used the alternate attraction and release of an electro-magnet, giving a reciprocating motion to an arm-

ature, and this was easily converted into rotary motion. These devices obtained their electricity from batteries, and were comparable as a matter of principle to a device which might be made by attaching a tiny connecting rod and crank to a telegraph receiver. None of these early electric motors were of any practical value whatsoever in serving for motive power.

The electric motor which is the live issue of to-day is based on the principle that, while a dynamo will generate electricity if power is applied to revolve the armature, yet, on the other hand, if electricity is applied to the dynamo, the armature will revolve. The machine is reversible; and this reversibility has been wisely called by that eminent mechanician, the late Clerk Maxwell, the greatest invention of the century.

It undoubtedly resulted, as far as public attention was ever called to the matter, from a blunder of a workman engaged in putting up some electric lighting apparatus at the Vienna Exhibition in 1873, by which the wires were connected to one dynamo at one end and to another dynamo at the other end, and when one dynamo started, to the surprise of all, the other was set into rapid motion. As is usually the case with such inventions, there are others who allege that this well-attested incident was the result of design, to illustrate the discovery which they claim to have made previously.

It has been recently found that Dr. Antonio Pacinotti, the inventor of a magneto-electric machine, wrote a description of his machine in an Italian periodical in June, 1864, in which he says that it can be used to generate electricity, or as a motor; and he therefore is entitled to the credit for the invention of the present electric motor.

The relation between magnetism and electricity, by which the magnet of an electric motor can set in revolution by its attraction the copper wires conducting electricity in the armature of an electric motor, is well illustrated by applying a magnet to an incandescent lamp. When the lamp is not illuminated the magnet will not produce any effect upon it, but if the lamp is in use the magnet will attract the filament.

The same machine can and has frequently been used at various times as a dynamo for electric lights and at other times for a motor; but there are numerous mechanical and electrical modifications essential to obtain the best results in an electric motor. The first use of an electric motor in any of the cotton mills represented in this Association occurred in a thread mill in Newark, where a dynamo was used in 1882 as a motor to run a lot of thread-winding machines.

Electric motors are now used for hundreds of purposes, but this paper will be confined to references to their uses in cotton mills.

Electric motors are frequently proportioned to use low-pressure currents of electricity, like those employed for direct incandescent lighting.

There are many places where motors can be operated by wires from any of the direct incandescent lighting dynamos; but, if the power required for the motor is more than about one-fifth that required to keep the whole number of lamps lighted, the lights will rise and fall in brilliancy, like those in an electric car when the motor starts and stops, the lighting service is unsatisfactory and the life of the lamps diminished.

The problem is one which must be worked out in each case; sometimes, when a small motor is required for use at short intervals during the day, it might be the more economical to use conductors from a large dynamo which is already installed for lighting the mill at other times. If constant service is required from the motor, then a separate generating dynamo is advisable; and it may be said that in the generality of work it is preferable to put in a generator suitable for furnishing the current to the motors.

The principle holds as good in electric apparatus as in all other machinery, — that more satisfactory results are obtained when there is no attempt made to require a more varied service from any machine than it is fully adequate to furnish.

It is generally advisable to use electricity for the transmission of power at a much higher pressure than that found best

suited to incandescent lamps, because there is a great saving in copper for conductors, and a lesser proportion of the electricity absorbed by the resistance of the wires.

The current of five hundred volts' pressure used for the trolley system of street-car propulsion is not capable of inflicting serious injury upon mankind, although frequently fatal to horses. There have been motors suited for use on arc-lighting circuits, but I believe that at the present time there are not any of them on the market.

Before deciding to install an electric power plant for a service outside of what is already fixed by precedent, expense, delays and disappointment may be avoided by deciding how much you are *willing* to experiment; and, secondly, how much the party doing the work *must* experiment before the whole installation is in a practical operating condition.

The fact should not be lost sight of that electricity is merely a substitute for other methods of transmission of power. It has its losses at every step in the course, comparable with those of the wear and tear and friction of shafting and belting. Like them, it also costs money, requires attendance, and wears out. It does not in any detail give something for nothing, but the results in comparison with other mechanical means of the transmission of power are merely the addition of a lot of differences. Sometimes these differences are on one side of the account and sometimes on the other.

An installation of motors in one instance may be extremely economical and in another highly expensive, in comparison to ordinary methods of transmission of power.

Electric motors, like water wheels or steam engines, have their highest efficiency at a point near to their full proper load, and on either side their efficiency in the percentage of electricity converted into work is diminished. The practical operation of some motors has been improved by the use of fly-wheels.

In its application for mill service, the most simple uses are those requiring a variable speed and direction, largely on account of causes outside of the electrical conditions in the

construction of such motors. It is especially advantageous for elevators in storehouses or other buildings not requiring power elsewhere. A motor can be attached to any elevator machinery operated by a belt, and the elevator can be managed in the same manner as before, so that the men have nothing either to learn or to forget. The first motor used for operating an elevator in a cotton-mill store-house was placed in that service in 1882, and is in as good working condition to-day. Another use having a larger field is in its application for railways in mill yards and buildings. The Salmon Falls Manufacturing Company has twenty-one hundred feet of track in the mill yard, and is operating a trolley system of cars to move all their cotton, supplies, cloth and coal, with two men, thereby dispensing with the services of a team and three men all of the time, and a fourth man a part of the time. The car makes an average speed of six hundred feet per minute, and is always ready for service whenever the water wheel is running. Other mills use electric railroads from the cloth room to the store-house with even greater reduction in cost of moving the load.

There are two systems of overhead trolley propulsion; the ordinary single overhead wire, with the current returning through the wheels to the rails and thence back through the earth to the dynamo, is the simplest and the only one that has a practical system of switches in the wires overhead. This system contains a serious objection, in the electric sparks constantly occurring in the contact of the wheels with the rails, and liable to ignite any combustible substance there, and therefore could not be safely used inside of mills. For inside use it is necessary to use the double overhead wire system by which the circuit is made between the two wires, without using the rails as conductors. In either case the overhead wires should be thoroughly protected by guard wires whenever there is a possibility of telephone or other wires falling upon them.

Electricity is filling a most useful purpose in operating travelling cranes, and the few store-houses in mills which are provided with travelling cranes use them at such infrequent

intervals that it is probable that hand power is still the cheapest method of operation; but for erecting shops, and other places where constant service is required, electricity affords great advantages for working such cranes.

Motors have been applied to calico-printing machines with great success. The absence of heat, small amount of space, little momentum of the revolving parts, and the control by which the machine can be uniformly moved in either direction at any desired speed, are all advantages of the highest practical value.

Other classes of work require that the motor should revolve at as uniform speed as can be obtained by a water wheel, or better, if possible. Motors will revolve at a constant speed if furnished with a current of uniform pressure. A compound generator will produce a current at a uniform pressure with variations in the load or quantity of current required by the motors; and it will also to some extent compensate for slight variations in the speed at which it is driven. Therefore it may be said that the speed of an electric motor may be more uniform than that of the water wheel or engine from which it derives the power which it gives forth.

A variation in lights is not a direct measure of variation in a dynamo, because a change of one per cent. in the pressure of the electricity in an incandescent lighting system would cause a variation of several per cent. in the amount of light from the incandescent lamps.

The class of service for the distribution of power throughout a mill as a substitute for belt or rope transmission has not been tried in cotton mills, but there are many cases where it has been tried in machine shops and yielded excellent results. The amount of power required in cotton mills is so much greater than in machine shops that the subdivision should be to a smaller unit than a whole room in a large mill.

I am convinced that such a distribution of power is mechanically feasible; but will it pay to do so when motors and generators each cost nearly or quite forty dollars per horse-

power, or, including wire and foundations, over one hundred dollars for every horse-power transmitted?

Another class of applications consists in distributing the electricity from a central station in a mill yard to the various buildings.

The most complete plant of this kind is at the Edison Works at Schenectady, where seventeen hundred horse-power is electrically distributed to numerous shops situated at various places on a tract some twenty acres in extent.

The Thomson-Houston Works at Lynn have an extensive electrical distribution of power in their present works, and will have a larger power plant when their new works are completed.

At the Cumberland Mills in Maine two hundred and sixty horse-power is transmitted over a mile by the Mather electric system, arranged by Messrs. Stone & Webster of the Massachusetts Electrical Engineering Company of Boston; and motors are used to drive paper machinery, giving from poorly governed water wheels a sufficiently steady motion for calenders; but the compensation by the compound wound generators is not sufficient to remove the effect of all the variations of speed in the water wheels from appearing in the motors; and these motors cannot run Fourdrinier paper machines, although motors in these mills deriving their power originally from a steam engine perform satisfactory work in driving paper machines. At these same mills an installation of motors is under way for the transmission of twelve hundred to two thousand horse-power for a distance of seven miles.

As water wheels give sufficiently uniform speed for looms, and as motors do give a more uniform speed, there is but little question as to their mechanical suitability for such work.

The third class of applications for electric motors is in connection with long-distance transmission of power, for the purpose of bringing the energy of a water privilege to a locality more convenient for manufacturing.

The problems of short-distance transmission, already con-

sidered, are as different from those involved in the transmission for a long distance as river navigation differs from that on the ocean; and the extent to which these long-distance problems have been mastered was shown by the transmission of three hundred horse-power one hundred and nine miles, through No. 6 wire, at the Frankfort exhibition in Germany last year. There are power transmissions in California for mining machinery for long distances, some of them being twenty-seven miles; but I am not aware that any such great distance has been applied for driving textile machinery.

The electric lighting and power used in Hartford, Conn., is derived in part from a water power at Tariffville ten miles away, and some three hundred horse-power is transmitted along the wire that distance, and thence distributed to customers around the city.

The Nonotuck Silk Company is supplying to its mills at Leeds and Haydenville power transmitted by electricity from a dam in a rocky gorge in the river about a third of a mile from one mill, and a mile and three-quarters from the other. The installation is not cited as being on a large scale, but because it contains many ingenious features in the manner in which the motors are applied as an auxiliary and a regulator to the water wheels.

The fall of thirty feet is situated between steep banks, where it would not be developed under ordinary conditions, because the spot is unsuitable for the location of a mill.

There are two water wheels in use, one of ninety horse-power, driving dynamos which furnish nine hundred and fifty incandescent lamps on an alternating system at the mills. The other one hundred and thirty horse-power water wheel drives one Thomson-Houston generator of eighty-five horse-power and another of thirty horse-power, the pressure of the current being the same as that used on trolley street cars. At the mills one-third of a mile distant is one motor of forty-five horse-power, two of twenty horse-power, and one of ten horse-power, all supplied by electricity from the eighty-five horse-power generator.

The forty-five horse-power motor belts upon the main shaft, which is driven by two water wheels having a capacity of one hundred horse-power under a twelve and one-half feet fall.

The water wheels are run at full gate without any regulator, but the motor serves as a regulator, running at uniform speed and furnishing the remainder of the power, which has a variable range of twenty-five horse-power.

When the water falls too low for the water wheels and motor to run the mill, a steam engine is belted to the main shaft, the motor and water wheels furnishing their full capacity, and under these conditions the engine regulates the speed of the whole. It is an important precaution to set the governor on the engine for a speed slightly greater than its proportion to the motor and water wheels, so that it will lead and also prevent the motor from tending to do more than its proper capacity.

The other three motors are used to drive the machinery in an adjoining mill building, and they are connected directly to the shafting, one in each room.

The fifty horse-power generator at the power station operates a forty-five horse-power motor in the mill at Haydenville, a mile and three-quarters distant.

The arrangement of motor, turbines and engine is the same as at the lower factory, but placed in a more compact manner. Arrangements are being made for an increase of this electric plant, and Mr. Ira Dimock, the managing director, sends me word that he will be pleased to show this electric power installation to any textile manufacturers.

For long distances it is essential to use electricity at high pressure in order to avoid the necessity of using large wires. For this purpose the electricity is generated in alternating pulsations, known as multiphase currents, at great pressure; and, before entering the building where the motors are situated, the electrical pressure is reduced by a transformer and in that condition used by the motors.

Mr. Nikola Tesla of the Westinghouse Company is the inventor of this type of motors, which have been in practical use

for some time in the shops of the Westinghouse Company at Pittsburg.

It is this type of multiphase machines which offers the only feasible means for transmission over distances exceeding a very few miles, without such undue losses as to be out of the question.

These motors, being free from commutators or brushes, do not spark, are very compact, and easily start under a full load. Motors using multiphase currents are under construction by the General Electric Company.

There are several places in New England where the power of waterfalls is being applied through electrical apparatus to machinery at a distance, and there are numerous extensive enterprises of this nature under construction.

The electric transmission of power under any practicable conditions of constant or variable speed, at a loss not exceeding twenty per cent., has been shown to be entirely practicable; and the open question in regard to all of these devices, whatever may be their purpose, is but the question of cost.

It was my privilege, at a meeting of this Association held ten years ago, to present a paper on the subject of "Electric lighting in mills." The applications of electric illumination have grown during these ten years to such an extent that the daily manufacture of incandescent lamps in this country is now three times the whole number of incandescent lamps then in use in the United States, and I believe that there is no reason to question why there will not be in this decade a comparable increase in the applications of electricity to the transmission of power.

The PRESIDENT. You have heard the very interesting paper of Mr. WOODBURY, and if there is any one here who would like to say anything on this subject, we should be glad to hear from him, or if there are any questions to be asked in regard to the matter.

Mr. ATKINSON. As you are aware, a very large part of the finest silk and velvet ribbons manufactured on the continent of Europe are woven on hand looms. There are forty thousand hand looms on velvets, neck-ties and all that sort of thing in and near the town of Crefeld, where my son took lessons in weaving several years ago. The finest Lyons silks are woven on hand looms, because the silk-worm does not spin a uniform thread, and the size of the yarn regulates the number of picks that are put into each inch. In St. Etienne, France, there are eighteen thousand hand looms on silk ribbon. The most interesting experiment in the transmission of power that I have noticed is that in this commune of St. Etienne a contract has been made with the managers of the electric plant to put a wire to each one of those eighteen thousand looms for two years, as an experiment in operating household weaving by electric power, probably increasing product, raising the wages and diminishing the cost of production.

Mr. CLARKE. I would like to inquire of Mr. WOODBURY how high the power was, — how many volts, — in the case mentioned by him.

Mr. WOODBURY. I think about twenty thousand volts in the main circuit, using an alternating current; but this high electrical current is reduced by converters wherever it is used.

Mr. CLARKE. Isn't there some danger with a current as high as that?

Mr. WOODBURY. Yes, sir. While the arc-lighting currents in general use are generally fatal, these would act quicker, if that be possible.

A MEMBER. Does Mr. WOODBURY know of any instance where electricity is applied to the propulsion of street cars outside of the trolley system, in the shape of a storage battery?

It has been stated in the newspapers that it has been so applied successfully to street cars. If he knows anything about it, I would like to hear about it.

Mr. WOODBURY. The Milford Street Railway is operated by storage batteries, and they claim they are having very satisfactory results. It has been alleged that the expenses of transmission are more than by the single-trolley system; but I have been informed that these include the cost of preliminary experiments. On one of the largest horse-car systems in the United States the total cost of moving a car a mile was 24.73 cents, the average prime cost being 9.60 cents per car mile. With the use of electric motors they reduced the prime cost to 5.25 cents per car mile, the generators in the power station being driven by high-speed non-condensing engines, and this cost has been further reduced by using compound condensing engines.

Mr. KENDRICK. I should like to ask Mr. ATKINSON in what way the difficulties of weaving silk are obviated by operating with electric power.

Mr. ATKINSON. On account of the ease with which electric power can be modified or varied, the same as with hand power; so that the weaver can exercise the same supervision that he does when he works the machine with his foot. That is hearsay; I have no knowledge myself. It is experimental as yet.

A NEW COVERING FOR COTTON BALES.

By Mr. D. M. Thompson of Providence, R. I.

Mr. President: — The matter which I will now suggest for your consideration is one of great importance to the cotton industry; but, since it is not included in the list of topics assigned for discussion at this meeting, I will endeavor to be brief in presenting it.

My attention was recently called to a new method of covering cotton. It is a patented process invented in 1889, and known as the "King cotton bale covering." Sample bales have been exhibited during the past two years through the South, and have received the endorsement of the Farmers' Alliance Associations in seven of the cotton States. It has also been exhibited at the Cotton Exchange in New York, and may have been seen by some of the members present. A bale of cotton covered by the King method is now in the corridor of this building, and other samples can be seen at the Mechanics' Fair.

On the evening of the second of July we had a disastrous fire in one of the store-houses of the Royal Mills, owned by the Messrs. B. B. & R. Knight, at River Point, R. I. The contents of the building at the time of the fire comprised 4,360 bales of cotton, 418 bales of goods, and other valuable material and supplies. The net loss, after deducting salvage, amounted

to over $150,000, $90,000 of which was recovered by insurance. We had removed 1,200 bales of goods (or about $130,000 in value) from the building but a few days prior to the fire. We decided to sort, pick and handle this cotton ourselves, in doing which an area of twenty acres of ground was used, and the services of about two hundred hands were employed for a period of seven weeks. The experience derived from this cotton fire, the hundreds, I might almost say thousands, of outbreaks of fire in the cotton during the period named, together with the care and responsibility of putting about five hundred bales per week into our several mills within the Pawtuxet valley, constituted an object lesson in cotton fires which I shall never forget.

It is doubtless for this reason I am deeply impressed with the importance of the subject, and the serious necessity of discovering and adopting some better method than has heretofore existed for covering and baling cotton.

There has been but little improvement over the early methods of baling cotton, other than the introduction of iron hoops and ties, with the patented clasps (introduced about 1865), which enabled the fibre, enclosed in jute covering, to be compressed into more compact form for shipment. A variety of new systems have been proposed, indicating a recognition of the demand, but without successful result. It has been difficult to find a material which would compete with the jute bags and the six steel ties, the cost of which is now eighty-five cents for one and one-half pounds, ninety-five cents for two pounds, and one dollar and five cents for two and a half pounds bagging. Since but little of the one and a half and two and a half pound bags are used, the cost to the farmer may be taken as ninety-five cents per bale, while the rebate to the spinner in the sale of bags and ties is about twenty-seven cents.

The King cotton bale covering consists in a wrapper called "asbestos," but which is made of a vegetable material largely

composed of cotton stalks ground into a pulp and treated by a chemical process, which renders it absolutely indestructible by fire, and for practical purposes is substantially impervious to water, while it possesses the properties of absorbing or imparting moisture as affected by atmospheric conditions. The covering thus composed is made into a sheet of about three thirty-seconds of an inch thick; within the central body thereof is laid a fine wire cloth of one-quarter inch mesh, which gives to the material a firm and reliable structure. This covering is then laid in two sheets, one above and the other below the bale to be covered; the edges are overlapped, thus completely enclosing the cotton. The bale is then secured by means of a galvanized-wire cloth of two-inch mesh, made of No. 18 steel wire. It is made of a width slightly less than the breadth and thickness of the bale, and cut off in lengths required. When the bale has been compressed to the density required, the selvedge edges of the wire cloth cover are fastened by means of wire hooks, or wire woven therein, thus uniting the aforesaid selvedges, as also the ends of the bale. The weight of this cover is about the same as two-pound bagging, and I am assured by the inventor, supplemented by the written proposals of the manufacturers, that it can be sold to the farmers at a cost not exceeding seventy-five cents per bale, allowing the present discounts or commissions of the jobbers. It will therefore effect a saving of at least twenty cents to the farmer, nearly equal to the re-sale of bags and ties; while the material in the covering, it is believed, will prove of at least as much value as the old jute bags and ties.

An exhibition of this system was made in Providence recently. Several gentlemen engaged in manufacturing and as shippers were present. A good average well-covered and closely compressed bale of the ordinary method was selected for comparison with the sample bale of the King covering. The estimates of relative weights, as expressed by those present, were five

hundred pounds for the ordinary bale, and from three hundred and fifty to four hundred pounds for the bale with the new covering. The bales were then put upon the scales and weighed, with the following results: The common bale weighed 497 pounds, comprised 32.15 cubic feet, and contained 15.46 pounds of cotton per cubic foot. The bale covered by the King method weighed 505¾ pounds, comprised 24.2 cubic feet, and contained 20.9 pounds of cotton to each cubic foot. The relative density was as 1.35 to 1 in favor of the new method. The value of this feature alone is an important factor, since the cost of transportation, either by rail or vessel, will be reduced in very nearly the proportion of the saving of space, which, in the case here cited, enables an increased carrying capacity of at least twenty-eight to thirty per cent.

The King cotton bale covering, as shown by the samples, presents a clean and smooth appearance, at once suggestive of a security from loss by fire never before known. It also indicates an intelligent appreciation of the worth of this so-called "raw material," the farming value of which in 1891 was $366,863,738. The most vital and important feature to be considered in connection with this improved method of covering is its fire-protective quality. I have carefully examined the records of fire losses in which cotton has been involved, also extending the inquiry into the fire losses of other properties, for the purpose of a better consideration of the subject. I confess that I am amazed, in view of the terrible tax which is thus imposed upon the industries of the people through the destruction of property by fire.

The property loss by fire in the United States in the year 1875 was $78,102,285; in 1891 the loss was $143,746,967, involving 37,282 fires or risks. During the seventeen years 1875–91, the property loss by fire was $1,618,323,306. During a period of eight years, ending with 1891, the property loss in cotton fires was $24,444,284, distributed as follows: —

2,405 fires were in cotton-gin houses.
343 fires were on wharfs, platforms and at compresses.
226 fires were in cotton warehouses and store-houses.
511 fires were in cotton goods factories.

During the year 1891 there were 747 cotton fires, the property loss of which amounted to the enormous sum of $5,084,747, upon which there was an insurance loss of $3,590,304, and a net property loss above insurance of $1,494,443. The ratio of the number of cotton to all other fires exceeded 2 per cent., and of loss to all other losses by fire 3.54 per cent.; while the ratio of insurance paid to that upon all other losses was 3.96, or nearly 4 per cent.

This exhibit confirms the attitude of insurance companies, who claim that the loss upon cotton risks exceeds the present premiums, and as a result of which many of the companies are declining to write further insurance. The King method of baling has been examined by the leading insurance companies, including the marine underwriters, and reliable propositions have been received from them, which guarantee a reduction of fifty per cent. from present rates. In view of the records and general experience, it is possible that the actual risk will be reduced very much more than above stated, since upwards of sixty per cent. of cotton fires have their origin in locomotive and other sparks, while a large percentage are of incendiary origin.

This is a subject which justly appeals to the reason and good sense of all men, whether engaged in the cotton industry or otherwise, because the loss of property by fire is a tax upon the resources of the nation. Cotton fires are greatly to be dreaded, since they are almost impossible to extinguish, and the losses, as has been shown, are nearly twofold greater than in the average of all other risks. The importance of this subject is becoming more generally recognized than in former years. In 1891 about 6,200,000 bales of cotton were exported for the use of European spinners. Its value was nearly $250,000,000.

The feeling among the English shippers and spinners is already deeply aroused, and an almost imperative demand is now being formulated, through an appeal to the British Parliament, in the hope of securing a better and more safe method of packing cotton. Early legislation is expected, which will prohibit the transportation of cotton upon passenger steamers or vessels.

The "Liverpool Journal of Commerce," July 9, reports Lord Balfour of Burleigh, in his reply to the interrogations of the Earl De La Warr, in the House of Lords: "From documents in the possession of the Board of Trade I learn that in the last ten years there have been one hundred and seventy-one fires on cotton-laden ships crossing the Atlantic from America, and of these, eighty-one occurred in the port of loading, forty-five in the port of discharge, and forty-five during the voyage." It is also claimed that during the past thirty years no less than ninety vessels and over two thousand lives have been lost by the burning of cotton-laden ships.

This is a grave and serious question, — one which concerns the interests of Americans far more than of Europeans. It is especially one of vital moment to the best interests of the cotton-producing States, and should receive their early consideration. The estimated wealth in real and personal property in the United States in 1860, per capita, was $514, and above $1,000 per capita in 1890, or $63,648,000,000. The assessed valuation for purposes of taxation in 1890 was $24,652,000,000. The loss by fire in 1891 is therefore equal to a tax of 60 cents on each $100, or a per capita loss of $2.30. The increase in per capita wealth in the ten years 1880–90 was about $130 (or $13 per annum); hence the fire loss of 1891 was equal to a per capita tax of about 18 per cent. on the net increase of the per capita wealth.

The exhibit of fire losses, very briefly referred to, are startling facts, and suggest the imperative necessity of both State and national legislation with the purpose of more efficient laws for the protection of property. In presenting this subject I

have given special emphasis to the means of protection from loss by fire which this method of baling cotton will secure. There are other valuable considerations which will doubtless commend it for adoption. There are possible objections which may be raised by the middle-men and the cotton brokers. I have not as yet discovered objections which are to be regarded as worthy of serious consideration, as against the many advantages which appear so conspicuously in its favor.

I respectfully suggest, Mr. President, that the matter be referred to the Board of Government (or a special committee) for investigation, because I believe it is a question worthy of the serious attention of this Association.

Mr. BOURNE. What is the character of the cotton packed in this way, after it has gone to the mill?

Mr. THOMPSON. I have not yet ascertained its condition. I have not seen a bale opened. It is for this reason I have refrained from especial comment upon this phase of the subject. I have no doubt, however, that we shall find the cotton in a much better condition than in the ordinary bale covering. It will be clear of dirt, sand, grease and other extraneous substances. I expect that a very material gain will be realized from the saving of fibre now pilfered in transit, as also a more ready cleaning of the covers, and the consequent saving of labor and the wastes of fibre which now adhere to the jute bags.

Mr. ATKINSON. About three years ago this Mason cotton baling was brought to my attention. The first invention was one in which the inside covering of the bale was made of an impervious substance, that, although it was fireproof, would enclose the air and the humidity in the bale, and would expose it to dry rot in three months. I told the inventors they could not introduce such a bale covering as that; that they must find some substance which would reject flame and at the same time let the air into the bale. They then took up the asbestos and wire covering, which is suitable for this purpose. The bale re-

tains its shape in this covering and does not bulge. There are several points about it worthy of notice: The bale covered in this way will not readily soak water, while the compressed bale covered in the ordinary way will soak water rapidly. This style of bale is dense, much more so, I think, than Mr. THOMPSON stated, — so dense that I think it will not absorb water or oils. This covering costs less than the other and is no heavier. It has a large number of merits and I am unable to find any outs about it. I think the wrappers when removed will be worth more than those at present used, and could be more easily saved for further use. Whether the planters will take to it I don't know. They are under the delusion that they are now selling the manufacturers the bagging at the price of cotton, but they are not. I hope you will appoint a committee to investigate this matter, as it is one of great importance.

Mr. BAKER. I move that the question of cotton bagging or covering be referred to the board of government, and they make such investigation, by a committee of themselves, as they may consider needful, and that they report hereafter. (Motion carried.)

Mr. ATKINSON. Plates will now be exhibited, showing the Vicars system of automatic stoking, as practised in England. They will be followed by plates representing the Roney system.

A number of pictures from lantern slides were shown, representing various English establishments where the Vicars automatic stoker was in use, giving interior and exterior views, in illustration of Mr. ATKINSON'S paper.

The members present then adjourned to the Thorndike Hotel, where an excellent dinner was served, after which the President announced the topic, "The Vicars automatic stoker, and rope-driving; with other appliances noted in English cotton mills," by Mr. EDWARD ATKINSON of Boston, Mass.

Mr. Atkinson. After fifty years of work I went abroad for rest and recreation. I didn't mean to go near a cotton mill or factory, or to do any work at all. But among the very wonderful things one may see in London is the Greathead tunnel under the Thames, consisting of two iron tubes, each ten feet in diameter, sometimes alongside of each other, sometimes one on top of the other, the tube put in in segments from within the bore, and protected outside with cement also placed there from within. It was carried through under heavy masonry; it passes within thirteen inches of the bottom of the Thames, and is now so absolutely dry that no pump has been required; and no drainage even, if that were possible. The cars are operated by electric power from the Surrey side, three and a quarter miles from the point of beginning on the London side near the monument, right in the heart of the city. I think this is one of the greatest wonders of mechanism yet produced. There are singular points about it, among which are these: the temperature is constantly 54°, and it is uniformly clear and dry. Objections were taken by our commissioners to it, that the change from the hot surface air to this cool temperature might be dangerous; but it is so dry I don't think there is any shock at all; it is not as noisy as I thought it would be; you can converse easily with the person sitting next to you. I was introduced to Mr. Greathead, and he placed me in charge of his chief assistant. We started on the Surrey side, entering what had been a dwelling-house, with a large garden behind it, which had been chosen for the steam plant. We passed from the dwelling-house, now used for offices, to the boiler plant, and there I observed a chimney of large section, about seventy feet high, through which the draft for a boiler plant of fifteen hundred horse-power capacity was operating at eight hundred horse-power. The first thing I observed was that there was not a particle of smoke from the top of the chimney. I then inquired of the engineer how that was, and he said that it was the residential district, where the ordinances would not permit

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any smoke. "But what are you burning?" said I. He said, "We are burning bituminous dross." What they call dross is a very low grade of bituminous coal, not commercially known or sold here, so far as I can find out. I asked, "How is this done?" and he said, "By the Vicars automatic stoker." You have seen the drawings representing this apparatus, which were passed very hastily before you this morning. The method is that of *smoke prevention*, not of smoke consumption. It attracted me so much that I felt it a duty to investigate it further.

My friend Mr. Sterne then took me to the great refrigerating houses, of the capacity of three hundred thousand frozen New Zealand sheep at one time, with the refrigerating plant in the heart of the city, on the Thames, where it is operated by the same apparatus without smoke. It then seemed to me that I ought to go further; and, taking a list of those who had put this apparatus into use, I found among them our friends of the Coats Thread Works at Paisley, and, as I was going to the meeting of the British Association for the Advancement of Science at Edinburgh, I made a special trip to Paisley to review this method. Unfortunately I had not learned that since the Coats Mills went into a limited company it is no longer a show place; no one is permitted to go into the mills without an order from the board of directors. I could easily have got one if I had known it in time. The superintendent, however, did not feel at liberty to admit me to the mills; but I went over the steam plant with Mr. Motion, the superintendent of engineering. I first reviewed the steam plant of the very latest mill, of which you got a glimpse in the plate that was shown you. That is a monumental mill. I did not like it in its outside appearance as well as the previous mill plant built by Mr. Motion himself, strictly for utilitarian purposes. I did not think it looked as if it were as well adapted to use as the other one. In connection with the last mill there was a plant of ten Lancashire boilers, each of four hundred horse-power, four thousand horse-power in all, that were being served with dross

fuel brought from about twenty miles distant. This fuel is of a very poor quality, — surprisingly poor to any one who has seen coal consumed here (the ash being about eighteen per cent). It is very fine stuff, requiring no preparation for the stoker. This fuel was brought about twenty miles from the mine, dumped into pits next the boiler house. It is taken automatically from the pit, along the top of the boiler plant, out of sight, by an endless screw or conveying apparatus, delivered to each boiler in due order and fed automatically. Again not a particle of smoke to be seen from the top of the chimney. I went through the details very carefully with Mr. Motion. There were but three men employed in the entire charge of these ten boilers, and they didn't seem to have much to do. Mr. Motion bore testimony to the great economy in handling and the perfect regularity of the process, as well as the general saving in the whole method of generating steam up to a certain point. He did not give me the exact data about the pounds of water evaporated or the economy in the use of the fuel itself. The testimony was complete as to the conveying and handling of the fuel, but it was evident there could be no rule taken from that plant as to evaporation or pounds of coal per horse-power per hour, on account of the very low grade of fuel used.

I took some notes, which I had hoped to have here, which would enable me to go a little more into detail than I can now; but my trunk unfortunately was left at Liverpool, and I have not yet recovered it; all my papers are there. The Messrs. Coats, have, however, permitted Mr. Motion to send me complete working drawings of the entire plant, which are now in possession of Mr. Howatson, who desired to show them to some persons here. They will be in my possession again very soon, and, if it shall be thought fit to make any considerable report upon this subject, I have all the data to present it, with the illustrations, in a complete way.

The evidence is absolute and conclusive, that smoke prevention is within reach, and that it has attracted attention and is

practised by the very largest establishments in Great Britain, where they have the highest engineering skill in their own control. The great sugar refinery of Tates in London — many of the largest public works which there are supervised with more care than they are here and where the adoption of any improved method is better testimony than it would be here — may be mentioned in this connection. These matters are fully presented in the circulars which the representatives of the art will put before you.

The point of most singular interest in this connection was to learn that our English friends are being forced to economy in fuel, by the very rapid rise in the cost both of production and distribution. The change in the prices of fuel to the thirteen principal railways in England, between 1888 and 1891, was very great, the increase in price amounting to $6,500,000,— a sum, as I recollect it, equal to one and one-half of one per cent. on the capital of the railways referred to. Mr. Howatson tells me that in many of the mines the larger veins have been driven so deep that they can be worked no longer; they are now working back, and are taking up nine-inch veins previously passed to secure the coal that is left in such mines. In certain districts, London, for instance, the price of coal is higher than in Boston. The price of coal at Brown's Hotel in Dover Street was $6.50 per long ton, for as good quality of smokeless coal as would correspond very nearly to the Pocahontas or Cumberland; not quite so hard as our semi-bituminous, but harder than Pittsburg or western coals. Of course the factories nearer mines get the coal cheaper than we do in New England; but I do not think that the factories in England which are at a distance from the mines corresponding to the Pennsylvania factories are furnished with fuel at as low cost as some Pennsylvania factories near the mines. In other words, the tendency of the price of fuel is rapidly upward. Therefore the English are utilizing a material that has been heretofore unmarketable. The coking coals used in steel works are approaching exhaustion. The Durham mines are over two thousand feet deep, the tempera-

ture 104°, the vein lies only two feet in thickness; the price of coke for steel making is about four dollars per ton. In our steel sections it is, I suppose, about two to two and a half dollars. Coke costs at Pocahontas about $1.40. I think it costs less than $1.25 at McConnellsville. Therefore a necessity has arisen in English engineering to push economy to a point which we have not been forced to reach here. Moreover, we are just beginning here in New England on bituminous coals. In England they have never had much experience with anthracite. They are now making use of the Welch anthracite to a limited degree, but it is a small element in Great Britain's supply of fuel.

I cannot go into a technical description of the automatic stoker; that must come in the report, if the government thinks it worth while to make a minute report, which I hope they will. I add a letter from Mr. Dobson on the coal question which will interest you.

EDWARD ATKINSON, Esq., *Boston, U. S.*

DEAR MR. ATKINSON:—On my return from London this morning I find yours dated the 3d inst., and hasten to send you such information as I think will be interesting on the subject of "smoke combustion."

For twenty years I have been interested in the question of smoke prevention, which with Lancashire coal is a real difficulty I may say that there is little or no difficulty in securing a complete combustion of coal, if the circumstances are favorable, which simply means that there is a surplus of boiler power. This, as you well understand, in an old manufacturing centre like ours in Bolton is not always the case; and in my own firm we have one or two cases where it would be physically impossible to increase the amount of boiler power, as, for instance, in a boiler between two buildings where there is no possibility of enlargement or putting down an extra boiler. This is a frequent condition, especially in old mills. To put the matter in a few words, there are two classes of what are termed mechanical stokers; viz., the "coker" and the "spreader." The coking stoker, as you may be aware, feeds forward the whole thickness of the fire in bulk at a speed arranged according to the necessities of combustion; and, as fresh coal is fed in from the front, it is evident that the smoke must pass over the clear fire before it can get into the flues. There is no possibility of dense smoke making its way over the clear fire unconsumed. There are two or three kinds of mechanical stokers, and I am not prepared to say that one is better than another. They have all answered admirably in various places. The spreading stoker depends upon either velocity or spring action to sprinkle on the fire a continuous stream or quickly intermittent supply of fine coal. In this stoker there is also a movement of the fire bars, which tends to feed forward fire, and thereby breaking up the clinker and allowing air to pass. This is not so perfect a smoke consumer, but has the advantage, which is a considerable one in the case of limited boiler power, of enabling more steam to be got out of the boiler. Thus in one

case, where I tried the experiment on one boiler with three different kinds of smoke-consuming apparatus, the one as a spreading stoker was taken off for the purpose of applying a forced-draught smoke consumer; this, however, did not run many days, as it was the cause of considerable stoppage in the shop that it drove owing to failure of steam. This was therefore taken off and the boiler hand fired whilst preparing for a coking stoker. The coking stoker was one of the best of its kind, and a very admirable arrangement, but had the inconvenience of not keeping up pressure of steam, and after trying this for some six weeks, altering the inlet and the bar space, we were reluctantly compelled to remove it and replace the spreading stoker.

The spreading stoker is a good smoke consumer so long as the fire is kept well broken up and brightly burning, and is also an economy in consuming of fuel as compared with hand firing; but as the fire is not so graduated in combustion as in the coking stoker, it becomes necessary occasionally to assist the clinking motion of the fire bars by the use of the poker. This invariably causes volumes of dense smoke, which last about half a minute and die off altogether in a minute or two. Where power is very varied, as in rolling mills and bleach works with heavy calendering, there is not the same economy in the use of stokers as in the case of textile mills where the power is constant, because by hand firing the pressure of the boilers can be worked up quickly as required and the fires banked when the steam is not required; this of course is out of the question with the stoker.

It is of course an advantage in the working of either class of stoker to have it combined with an automatic diaphragm damper, which by the pressure of the steam will regulate the action of the stoker.

We have also applied this automatic action to the small steam jets which are allowed to play upon the bottom of the fire bars to cool the bars and assist the draught, so that when the damper valve makes the stoker cease working the steam is also turned off the small pipes, and consequently little or no combustion goes on. I hope that with your present knowledge of these apparatus I have made myself clearly understood.

Now, with regard to the question of coal, you are perfectly correct in your conjecture as to the price being now at a higher point than it has been previously. I find we use almost exclusively small slack in our boilers now. The present price of slack is 6*s*. 9*d*., and the price of "burgy" or round coal is 10*s*. 0*d*., delivered at the boilers. In the mechanical stokers slack is more suitable than round coal, and we therefore have the advantage of having a more suitable material at a much less price. In 1887 we paid 4*s*. 10*d*. per ton for slack; in 1890 we paid 9*s*. 7*d*.; and this year we are paying 6*s*. 9*d*., and at present we can see no probability of the price of slack going so low as it has been. As a matter of fact, for some reason or other the price of getting coal has been permanently raised; and, further, the use of mechanical stokers has created a demand for slack considerably superior to that of some years ago, when slack was almost a drug in the market. With a view of your making comparisons if necessary I enclose you a list, giving the price of burgy for some years past.

In case you do not have the information, I may say that the following are the names of the various kinds of stokers that have come under my notice: "coking" stokers, Vicars, Sinclair & Cass; "sprinkling" or spreading stokers, Proctor, Bennis & Hodgkinson.

You must quite understand that I give no opinion as to the respective merits of one system or the other or of one patent over another, but will simply conclude by stating that when there is available boiler power there can be no difficulty in avoiding smoke, and in any case whatever system is adopted the skill and attention of the fireman are always of value in preventing waste of fuel and issue of smoke. At the time I am writing I have had for two hours immediately under my observation the chimney of the boiler that is most pushed for work in our establishment, and in that two hours there has

not been a sign of smoke. This boiler is thirty-two by seven feet, Lancashire type, Galloway's water tubes, and is evaporating one thousand gallons per hour, with feed on eleven hundred-weight per hour, with feed off nine hundred-weight per hour. You of course have full liberty to use my name as responsible for the statements I have made, and, should you require any further information on this or other subjects, I hold myself at your disposition.

With kind regards, I remain yours very truly,

BENJAMIN DOBSON.

KAY STREET WORKS, BOLTON, Oct. 15, 1892.

Price of Coal per Ton (1870 to 1892).

YEARS.	MONTHS.	Engine Coal.		Slack.	
		s.	d.	s.	d.
1870,		5	11	–	
1871,		6	4	–	
1872,	January,	8	6	–	
1872,	June,	10	6	–	
1872,	August,	12	2	–	
1872,	October,	14	8	–	
1873,	January,	17	2	–	
1873,	March,	18	4	–	
1873,	July,	17	2	–	
1874,	January,	15	6	–	
1874,	March,	12	0	–	
1874,	July,	10	5	9	2
1874,	October,	8	9	7	6
1875,	January,	9	7	8	4
1875,	April,	8	9	7	6
1875,	September,	8	9	7	6
1876,	January,	8	9	7	6
1876,	April,	7	11	6	8
1877,	January,	7	6	6	3
1878,	January,	7	1	–	
1878,	September,	6	10	4	9
1879,	April,	6	6	–	
1880,	January,	6	9	–	
1881,	January,	7	1	–	
1881,	March,	9	6	–	
1881,	June,	7	6	–	
1882,	January,	7	11	–	
1883,	June,	7	6	–	
1884,		6	8	5	5
1887,		6	3	4	10
1889,	January,	6	8	5	1
1889,	July,	6	11	5	9
1889,	October,	8	5	7	3
1890,	January,	10	5	9	3
1890,	July,	10	0	9	0
1891,	January,	10	0	8	0
1892,	January,	10	0	7	3
1892,	October,	10	0	6	9

You may remember that in 1883, when I returned from England, I reported to you upon automatic stoking as just in its beginning but sure to take the whole field within a reasonable time. There is now much greater attention being given on the other side to boiler setting and boiler casing, so far as the brick work and surroundings are concerned. The last thing I hap-

pened to say to Professor Shaler before I left home was, that we had absolutely no science of brick in this country; that is to say, little or no knowledge as to the relative qualities and different kinds of brick with respect to non-heat conduction, — a most important element in dealing with boilers. You remember that when we first began to advise you to put your steam pipes in factories overhead rather than against the side walls, we called your attention to the fact that you would get from two coils of pipe placed in that way as much heat as you had before attained from three coils when they were placed close to the brick wall. I attributed that difference to the rapid absorption of heat by the brick and the partial distribution of the heat to all out-doors through the brick wall. It is a good deal so with a great many boiler settings that I have seen, where you are wasting a vast deal of heat down below, under the boiler; no distinction being made as to what kind of material the foundation should consist of, with reference to the quick or slow conduction of heat, and very little or no attention being given to the material of which the walls are made.

We have had one fire in a factory owing to the carbonization of the ten-inch post, which was carbonized through the end wall of the boiler setting sixteen inches thick. There is a great waste of heat in this way. There are a great many kinds of brick more expensive than common brick which are non-conductors of heat, as everybody knows; but there has been no scientific investigation of that matter, and I don't believe there is a man in Boston, or at this table, who can tell anything about the relative conductivity of one kind of brick as compared with another, except in a very rough-and-ready way. We use fire brick here, and we use common brick there, and that is about all we know of the matter. What the difference is, why, we know not with any certainty.

That leads me to call attention to what I learned on m out from this country of a recent American invention. steamer was Mr. F. Hopkinson Smith, author, who also Franklin H. Smith, artist, and Mr. F. H. Smith, a ve

contractor in New York City for such works as the foundation of the statue of Liberty on Bedloe's Island, — three men all wrapped up in one. He told me of this invention, of which I have a little sample here. It is a bit of artificial stone which is said to be more dense and to have greater power of resistance to crushing force and greater tensile strength than the best sandstone found in the United States. It is made of sand, magnesia and chlorine in some form; it sets in twenty-four hours without heat, and makes this material. The polish is brought about by molding in a pine box on a plate of glass. It looks more like a stone than anything artificially made before. Now, if this proves to be a success, it will be an ideal boiler encasement. It is likely to be a very cheap material, which one can afford to spread over a boiler foundation, and of which the walls may be made. By its use you may encase your boilers in a non-heat-conducting material, — just as I encase my little sheet-iron oven in the non-heat-conducting wall made of paper of which the outer oven consists. If this material does not prove to be suitable, there is now a great choice in the brick that may be used and in the material to be put under the boilers. Has that matter been explained? I think not. When I addressed you on the science of cooking at the last meeting, I told you what little experience I had in the complete combustion of heating material and the encasement of the heat, and what I had learned of the non-conduction of heat. On that limited experience I predicted the time when your tall chimneys would stand as monuments of ignorance and wasted material. One-half or more of the height of those chimneys is superfluous already. You are approaching the period when by the complete combustion of the fuel and the encasement of the heat around the boiler you will get the greatest amount of work and evaporate the largest amount of water, perhaps without any chimney.

What we want is a unit for the comparison of the cost of manufacturing steam. It might be put in this form: At what cost are one thousand gallons of water evaporated? How much

coal used? What kind? At what price? I have submitted herewith a table of questions which may lead to the establishment of such a unit.

When I came home, I will say to my English friends here, I was very glad to find that American inventors were working in the same direction. The Roney system, coming east from the far west, taken up by the firm of Westinghouse, Church, Kerr & Co., is being established in this neighborhood. It is another method of accomplishing the same purpose. If you will go to Curtis Davis & Co.'s works in Cambridge you may see a plant not yet completed, where they are consuming our ordinary Pocahontas coal without any smoke from the chimney stack, which is twenty-five feet in height above the roof of the boiler house. It is of iron, and upon the outside of it I am told you can bear your hand. It is a mere *prima facie* case I put before you as far as this matter is concerned. My intention is to keep informed in regard to it, and I make these suggestions for you to follow out in detail. By this American invention there is a complete combustion of fuel; there is claimed to be a large evaporation of water, and it is claimed to be a method that will rival the English method. Between the two you have an accomplished fact. Of course all the details must be gone into by experts who know the subject, as to the evaporation of water, consumption of fuel, repairs and everything else. The investigation I am making is merely preliminary. The subject is urgent in Great Britain, — very ripe here, for Boston is beginning to be infested with coal smoke so badly that the city council, while I was away, passed an ordinance forbidding the use of smoky fuel without some kind of smoke prevention or smoke consumption.

In the matter of smoke consumption, that subject was treated at the British Association for the Advancement of Science, at which the Sennett system was presented, of which I expect diagrams and description. It works the consumption of s made by imperfect combustion and is apparently very su ful. It is more likely to be successful in a locomotive

and in steamers than in plants like ours. If you can prevent smoke by complete combustion you will have no smoke to be consumed. Again, when I got home I found an American invention which corresponds very closely to the Sennett system. This apparatus is made by the Standard Smoke Consumer Company, 54 Lincoln Street, of which my friend and fellow townsman, Mr. Theodore Pinkham, is president. There is room for both, because there are many plants where perhaps smoke may be consumed with greater economy than it can be prevented; but in all the large plants the line of economy is in the direction of smoke prevention rather than smoke consumption. Smoke prevention is an accomplished fact in England, and is working with economy in labor and economy in fuel.

The common boiler used abroad in mill plants is either of the Lancashire or Galloway type. At first I had the impression that the Vicars apparatus might not be applicable to other types of boilers, and therefore I sent on to the Edgemoor Steel Works, in which they are manufacturing the Galloway boiler with great success, and obtained from them a complete set of drawings. Their type is different from the English. These drawings will be at the control of the government. But I do not think it will be necessary to limit the application of either of these methods of smoke prevention to any particular type of boiler. I have reason to believe that either the Vicars or Roney system can be applied to the kinds of boilers you now have as easily as to the Lancashire.

However, when you come to enclose your boilers in a non-heating medium, with a moderate draft, you will be free from some of the objections of contraction and expansion, and you may return to the types of boilers in which there are the fewest joints, the fewest tubes, and which are the least liable to leakage; that is, the old types which preceded the tubular upright boiler.*

* Since this address was given, the attention of Messrs. Wm. Sellers & Co. of Philadelphia has been called to the Vicars stoker, and I am informed that they have given an order for the apparatus for trial, with a view to undertaking its introduction in this country if it proves to be a success.

It was stated that I should say something about the transmission of power, but I shall not go into that subject now. I found the Messrs. Coats were using rope transmission, and that is the practice in all the larger and newer mills of Yorkshire and Lancashire. Our friend JOHNSTON says it is perhaps because they don't know how to make a good leather belt. I shall not go into that. I was inclined to believe in rope driving five years ago; I am inclined to believe in it more now than then, but I have no title to pass judgment upon it. I think the Englishmen would have procured good belts if they had not found a preference for ropes. The most scientific man in the world that I know of connected with cotton mills, Dr. Bowman, is enthusiastic for rope transmission.

I am told that there is a book describing the Curtis Davis plant, which can be had at the close of the meeting. I am authorized to invite you to look at their works at Cambridge. If you go there, I want you to look at another matter. Two of my fads which are bound to come into general practice within a short time are there applied. One is their new building, built upon the plan that the mill shall hold up the wall, not that the wall shall hold up the mill. You can put up a timber frame holding itself together, and you may put off your decision as to what the outer covering shall be until you have placed the shafting and machinery if you choose; you may then put on your outside wall to serve as a window frame. The building at Cambridge to which I call your attention is the glycerine house. That glycerine building is planned exactly on the lines of my circular No. 10, issued to you about ten years ago.

You will find at these works also, on the south side of the building, rough plate glass. Before I went [illegible] left instructions for experiments for determining t[illegible]ion and diffusion of light. I thought it might be [illegible]et some new types of ribbed glass, but I am s[illegible]s kind, of which here are several samples, is [illegible]

that no other kind is necessary. You will be surprised to know that the amount of light that is absorbed by this ribbed glass is ten per cent., and by the clear glass is eight per cent. There is only two per cent. difference in the obstruction of light between these samples which I have here. One is a double-thick German clear, the other is a fine-ribbed plate of same thickness. Now, through that plain glass you get no diffusion; your light falls directly on the floor, and the clear sunlight falls upon your looms or frames, making dark shadows; while with the ribbed glasses you get a diffusion through the room without a glare, you need no window shades and you have no dark shadow. Now, then, in the practical use of light, you will get a vast deal more with that ribbed glass without window shades than you will with the clear glass with the window shades which you must have on the south side. Moreover, it will pay you to put in thick glass rather than thin, in order to save the heat in winter and keep out the heat in summer. But I have only begun on the alphabet of this matter. The hammered glass is practically the same thing, but is not as good as the ribbed glass in the transmission of light in horizontal planes. I have a table here prepared by Mr. Hinman, giving the relative loss of light, which with ribbed glass is ten per cent., and with clear glass, double-thick, eight per cent., single-thick, seven per cent. The dispersion of light through the ribbed glass is relatively sixty-four degrees, as compared to 0 degrees in the plain glass. The relative cost per fifty feet is for one-eighth-inch ribbed glass five dollars; double-thick German, three dollars and a quarter. On the south side of Curtis Davis's laboratory you will find rough plate glass. I think there is room for a further development of the science of glazing, which is of great importance. I tried to find out if there was any science of glazing in England, where they use rough plate glass which is not so good as ours. They have no glass sand as good as the Pittsburg or Berkshire for the diffusion of light. At the meeting of the British Association an explanation was given of the Fresnel lens for trans-

mitting light in one beam horizontally. Now, by reversion glass apparatus has been made to serve as a diffuser of light for an arc lamp. The inventor worked on my theory of window glass. He has applied this idea to a conical glass which is put under the arc light; with this he has done away with the glare and destroyed the shadow. You may have daylight from an arc light in your mills without the shadow and without the glare. I have ordered one of those lamps to be sent to me.*

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* The following table will give the approximate results of a preliminary investigation of various types of window glass procured from Messrs. Hills, Turner & Co, which has been conducted by Mr. Charles W. Hinman since I left home. It is proposed to extend these investigations at a later day by the application of photography, which will give a more exact measure of the relative transmission of light than the methods formerly used.

What is called the ribbed glass has about twenty-two very fine ribs or flutes to the inch; No. 1 fluted has four deeper lines or flutes to the inch; No. 2 fluted eleven lines or flutes to the inch. The rough plate glass you are doubtless familiar with. Each of these types of glass has been justified in use in weaving rooms, laboratories, engraving rooms and the like. The point at issue is, which is the best?

The glass chiefly used in Great Britain is the rough plate. I think it is not the best. Neither, as I have stated, does their glass approach ours in clearness and translucency, because they have no sand equal to our own which can be applied to common purposes.

You will observe that the conductivity of heat is in the ratio of forty-seven in the use of the ribbed glass one-quarter inch thick, as compared to fifty-six with the use of the ribbed glass one-eighth inch thick, or the double-thick German, while the obstruction of light does not vary very greatly; it is ten per cent. in respect to the one-eighth inch, nine per cent. in respect to the one-fourth inch, which appears to be a more translucent quality of glass than the other eight per cent. double thick.

The relative price per fifty feet: seven dollars for the one-quarter inch, five dollars one-eighth inch, three dollars and twenty-three cents double-thick German. Whether or not the saving of heat would pay for the difference in price I am unable to compute. I am inclined to think it would.

With respect to the diffusion or dispersion of light there can be no question. The ribbed glass takes precedence. If it is judicious to glaze a mill with glass as heavy as one-quarter inch, then manifestly the preference must be given to the solid window frame as distinguished from the ordinary moulding and boxed sash, the upper light opening inward on a transom. I have made no computation of the relative cost of window frames, but one would infer that the solid fixed frame with transom window would on the whole be better and perhaps cheaper than the common frame with the boxing, pulley stiles, weights, etc.

As this matter of glazing is one of paramount importance, I will venture to add a word, while correcting the proofs, to what I said at the meeting.

In connection with my son, who is an architect, Mr. William Atkinson, I have been planning a school-house which shall be as well lighted, as uniformly and satisfactorily heated and as thoroughly ventilated as our best factories now are. One can see no reason why the requirements which must be met in the cotton factory in order to be

That is the substance of all I have new to tell you from this trip abroad. I am satisfied, however, that somebody who is more of a real scientist and expert than myself might well go abroad every two or three years, merely for the purpose of making observations of this kind. Our English friends are as much ahead of us in some ways as we are ahead of them in others; if we can combine the information which can be carried each way, we shall all soon be in advance of where we are now. It requires some tact and judgment to get hold of these things.

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successful in spinning and weaving should not also be met in the school-house, and at as low a cost relatively as the cost which we have succeeded in attaining in factory construction. My son has made the designs and has adapted our methods to the school-house and hospital, to the end that we can now make a contract for the construction of a school-house of excellent proportion and design, — simple and plain, to be sure, but wholly consistent with the motive and purpose of the building, — in which we can put four rooms on one floor to accommodate two hundred and twenty-four pupils; two rooms below for manual instruction, cooking, sewing and the like; ample provision for hanging the clothes of all the pupils, each in its own place; and the service of the building beside, — at a good deal less than twenty-five thousand dollars complete. In fact, a six-room school-house of brick, to accommodate over three hundred pupils, we can build for twenty thousand dollars, or even less.

In this building we propose to light every room from one side only, and by the use of this ribbed glass, where we can persuade school committees to adopt it in all but the lower lights, through which the children can look out if they please, we will transmit and diffuse the light so that it will be ample on the inside of the room as well as next to the window. When that is accomplished we will do away with the injury to which school children's eyes are now so much subjected by cross lights or by deficiency of light.

We have put all our plans, elevations and specifications into the customary form in which our factory plans and elevations have been put, so as to be ready to meet any requirements that may be made upon us.

Results of Investigations on Samples of Glass, by CHARLES W. HINMAN, October, 1892.

	Loss of Light. (Per Cent.)	Relative Conductivity of Heat.	Dispersion. (Degrees.)	Price per Fifty Feet.
1. Ribbed, one-eighth,	10	56	64	$5 00
2. Ribbed, three-sixteenths,	10	52	40	6 00
3. Ribbed, one-fourth,	9	47	54	7 00
4. Fluted, No. 1,	9	48	40	10 00
5. Fluted, No. 2,	9	47	56	8 00
6. Rough, one-eighth,	12	54	11	5 00
7. Rough, one-fourth,	10	48	5	7 00
8. Single thick, one-sixteenth,	7	58	0	2 28
9. Double thick, one-eighth,	8	56	0	3 23

See Appendix for closer results.

I have never had any difficulty in going where I wanted to and in finding out what I pleased; others can do the same thing; the man of the right sort will perhaps give as much information as he gets.

Appendix 1.

While correcting the proofs of this address it has occurred to me that the same method might be applied to proving that there is yet no true science of combustion that I adopted many years ago in order to prove to this Association that there was then no science of lubrication. That investigation led to a complete revolution in the manufacture and use of mineral lubricants.

I now assume that we have made a beginning upon the science of combustion and the manufacture of steam. It will be observed that the production of steam is an entirely distinct branch of manufacturing, which has heretofore been neglected because it has not been separated from the conversion of the product of the boiler into power in the engine, or its conversion to some other kind of work.

I now suggest that we may find out what it costs to convert each one thousand gallons of water consumed into steam. I am aware that there may be a difference in cost, due to varying conditions. It may cost more to evaporate quickly at high pressure than it does to evaporate slowly at low pressure, or *vice versa*, but we may make a beginning in establishing an average.

To that end I submit a series of questions corresponding to those which I formerly put about the use of oil. I will keep a private record of the names of all who make these returns to me, tabulate them by number, and disclose number and name together only to the representative of each establishment from which I may receive returns. There may not be as great a variation in the results of our present practice as there proved to be in respect to the quantity and cost of the oil consumed, but I imagine that there will be a very great variation.

These interrogatories will not be confined wholly to members of this Association. I will send them to other steam producers

in this country and in England. In this way we may secure exact knowledge in regard to the effect of automatic stokers, smoke-preventing and smoke-consuming apparatus, and we may judge of the relative economy of fuel here and elsewhere.

EDWARD ATKINSON.

Nov. 26, 1892.

THE MANUFACTURE OF STEAM.

Questions in regard to the manufacture of steam, sent in duplicate to members of the New England Cotton Manufacturers' Association and others. One copy to be retained and one returned to Edward Atkinson, Box 112, Boston, Mass.

These returns will be tabulated without listing the names of the establishments from which they come. Each establishment will receive its own number, and when a final copy of the summary is sent to each one who may contribute a statement of facts, the number of that establishment will be disclosed to its representative, but to no one else.

EDWARD ATKINSON.

BOSTON, Nov. 26, 1892.

QUESTIONS.

1. What make of boilers do you use? What type, and name of builder?
2. Are they fired inside, or outside?
3. If there is any material difference between your boilers and others going under the same name, please state the difference.
4. How many boilers have you in all?
5. Of what sizes and ratings in horse-power? Taking, as the standard of one horse-power, an evaporation of thirty pounds of water per hour, at 212° F., into steam at seventy pounds pressure.
6. How many boilers have you in any one plant?
7. What sizes and rating in horse-power?
8. Is your boiler capacity sufficient or otherwise for the work put upon it? Is the amount of steam required from your boilers variable in quantity at different times?
9. How many firemen do you employ in all?
10. How many firemen do you employ in one separate plant?
11. Do you use an automatic stoker?

except in answer to an existing demand. I therefore procured samples from Messrs. Hills, Turner & Co., representing ten varieties of glass of different thicknesses and of different kinds now on the market; to wit, what is called single-thick and double-thick clear German glass, French fluted, rough plate, fluted or corrugated, fine ribbed. Mr. Hinman also obtained two samples of fine ribbed from another source.

These have been tested and photographed, and I have selected six examples to be submitted in proof of the position that I have taken; namely, that by glazing windows upon the south side of a factory and perhaps on all sides with fine ribbed glass, one-eighth inch thick, in preference to double-thick clear German glass, one-eighth inch thick, so much better distribution of light will be attained, with so little additional actual obstruction, as to warrant the payment of five dollars for fifty square feet of the ribbed as against three dollars and twenty-three cents for the double-thick German clear glass.

The reasons are plain. The shadows will be less, or none. The glare will be done away with. Window shades may not be required, and, while one or two per cent. less light may pass into the room through the ribbed glass, the effective light will be increased by diffusion and bettered in every way. Such appear to be the results of this preliminary investigation. It will be continued and made more complete.

The source of light in these experiments has been the flame of an Argand gas burner, so that the light had already passed through one thickness of glass. In a few experiments the source of light was from a naked gas flame; but in this case the loss of light in passing through the samples of glass was almost twenty per cent. greater than when the Argand burner was used. It has not been practicable to apply sunlight in these experiments.

I now submit photographs of these examples of glass, by which comparisons may be made, and I will letter them in place of numbering, so as not to break the order of the numbers in which they were tested.

29. At what do you compute the value of your steam-generating plant, without buildings?

30. What increase, if any, in the steaming capacity of boilers has resulted from the use of crude petroleum as fuel, and what special information can you give on this subject?

31. What has been your experience, if any, in the use of natural or "producer" gas for generating steam?

Appendix 2.

Glazing.—Diffusion of Light.

It will be remembered that on my return from England several years ago I called your attention both to the form, construction and glazing of the English mill window, with a suggestion that in all points it might be better than our own. With respect to glazing I found the use of rough plate glass almost universal, but, as I then remarked, the English glass had a greenish tint from which our glass is free, owing to the better quality of our materials. Since then, several departments in our own mills have been glazed with the rough plate glass, and the experience in these works sustains my observation of the better diffusion and the slight obstruction of light. I did not feel satisfied with this rough-and-ready application in a case where a principle might be established. It seemed to me that the glass should be molded in ribs or prisms of such angle and shape as might most effectually deflect the rays of light and distribute them evenly throughout the room, and in this view the present investigation sustains me, the diffusion of light through the rough plate being very ineffectual as compared to the fine ribbed plate.

I began an investigation through Mr. Chas. W. Hinman, State gas inspector, before I left for England this summer, with a view to determining what should be the form of the ribs, flutes or angles of window glass so as to secure the most complete distribution of the light. I soon found that it would be impossible to induce window-glass makers to go into the matter

except in answer to an existing demand. I therefore procured samples from Messrs. Hills, Turner & Co., representing ten varieties of glass of different thicknesses and of different kinds now on the market; to wit, what is called single-thick and double-thick clear German glass, French fluted, rough plate, fluted or corrugated, fine ribbed. Mr. Hinman also obtained two samples of fine ribbed from another source.

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Kind of Glass.	Loss of Light by Transmission.		Angle of Dispersion of Light.		Relative Conductivity of Heat.	Price per Fifty Square Feet.
A. — Double-thick German, clear, $\frac{1}{8}$ inch thick, ...	8 per cent.		0°		56	$3 23
B. — French fluted clear, $\frac{3}{32}$ inch, . . .	8 per cent.		8° to 11°		57	4 25
C. — Rough plate, $\frac{1}{8}$ inch, ...	10 per cent		2° to 7°		54	5 00
	Smooth Side next to Light.	Rough Side next to Light.	Smooth Side next to Light.	Rough Side next to Light.		
D. — Ribbed, true curves, 18 to 1 inch, $\frac{1}{4}$ inch thick, ...	9 per cent	17 per cent.	73°	61°	48	Not given.
E. — Ribbed, not in true curves, outer flattened, 23 to 1 inch, $\frac{3}{16}$ inch, . .	10 per cent.	16 per cent	53°	44°	52	$6 00
F. — Ribbed, true curves, 23 to 1 inch, $\frac{1}{8}$ inch,	10 per cent.	27 per cent.	77°	73°	56	5 00

So far as these experiments determine a rule, it will appear that there is no considerable variation in the loss of light between clear and ribbed when the smooth side of the ribbed or fluted glass is put next the light, but that there is a very great variation when the rough side is put next the light.

It will also appear that the angle of dispersion is governed by the regularity of the curves, and that the best results in transmission are given from "F", $\frac{1}{8}$ inch thickness. The greater obstruction when the rough side is placed toward the light will prove that the rule is clearly established from this experiment, that in glazing the smooth side should be placed outwardly, the rough side inwardly. As to whether the ribs should be vertical or horizontal, will depend upon the size and arrangement of the windows. If the windows are high and narrow, with considerable space between them, the light will spread in a horizontal direction, and the ribs in the glass should be vertical. If the windows are low and wide, with only a small space between them, evidently the ribs of the glass should be horizontal.

A test of fine ribbed glass tinged but little with green, obstructed light fifteen per cent.; while white glass, of same thickness and type, obstructed it but ten per cent.

I trust that these experiments may constitute a beginning for the establishment of a true science of glazing, not only in factories and workshops, but in school-houses, college buildings, warehouses and other premises. But little progress in the art has been made since the days of Sir Joseph Paxton.

Many years since I suggested to the Association that a great saving in heat might be secured — the coating of windows with frost in winter avoided, the necessity for double windows done away with and the rooms also kept cooler in summer — if double glazing were adopted; that is to say, placing two plates of glass in the same sash, with about half an inch air space between. It is of course necessary that the plates of glass should be clean when set, and that the work of setting should be done with great care, lest dust should get in or air should

circulate between the plates. Air, when hermetically sealed, is one of the best non-conductors of heat, but when it circulates even slowly it fails in this respect.

The first trial reported to me of this method was not a complete success. Since then I have ascertained that the failure was probably due to poor work in the glazing. A film gradually clouded the glass between the panes. Since then this method has been completely justified in cotton and paper mills.

As the window is heavy, the fixed sash is best adapted to this method of glazing, with transom opening above the main window for ventilation. Two thin plates of glass set in this way would probably be better than one thick plate set in the ordinary way. On the south side the outer plate might be of the fine ribbed glass, the inner plate of clear glass.

As a theorist, I look upon this double glazing as probably more important in maintaining uniform conditions of relative humidity in a spinning mill than it may be in the control of heat. Cold windows and cold brick walls condense the moisture of the atmosphere within a mill, and thus render spinning uneven. It may happen that a spinning mill well constructed with walls of thick plank, plastered solid within or finished on the plank, roof of the most solid type, fixed windows, double glazed, with a solid plank floor laid directly upon asphalt concrete, may yet be chosen as the best type of mill in which to spin fine yarns of cotton or of worsted. The non-heat-conducting property of the timber, plank and double-glazed window might render it very much easier to control all the conditions of the atmosphere than it ever can be in the cotton or worsted mill as now ordinarily constructed, with brick walls and single glass, on which cold wind has great power. This is again one of my somewhat audacious theories, submitted to whomever may dare to put it in practice without recourse to me.

If this theory is well grounded upon the observed conditions affecting heat and humidity, then we may continue our quest for brick or tile made of the magnesian clays or limestones, rather than the common brick, since the magnesian compounds

are the best in respect to non-conduction of heat. This has been fully proved in our investigations of steam-pipe coverings; but, until we secure an absolutely incombustible material for the construction of walls which is also a non-condenser of moisture by being a non-conductor of heat, we may rightly consider the more free use of timber and plank than we have yet been accustomed to, — not only in the construction of mills and workshops, but also in the construction of suburban school-houses and hospitals.

I take the occasion to renew a previous suggestion in connection with this type of construction; to wit, *that the mill should hold up the wall, of whatever material the outside walls may be, rather than that the wall should hold up the mill.* In the ordinary method of construction of heavy outside wall of brick upon the ordinary chances of foundations while the posts are supported within on piers, a different rule of settlement in respect to the wall and a different shrinkage in the wall as compared to timbers has been developed, thus throwing shafting out of line and causing friction. If the framework is constructed in such a way that it can be roofed, floored and finished without any regard to what the outer wall is made of, then the problem of covering in that structure mainly with glass becomes a very simple one. The framework will stand alone or it will settle under uniform conditions.

If there should be a double line of posts around the outside, four or five feet apart, according to the width of the alley deemed necessary, these posts being braced either with hackmatack knees or with iron, such a framework will be absolutely stable against any wind pressure at side or end; especially if the floors of the alleyways are laid herring-bone fashion.

Objection may be taken to the posts at the end of the machines next the alleyway, but there is no more objection to a post at that point than there is to a post anywhere else. Upon such a framework an outer wall of brick may be attached in pilaster fashion, the brick surrounding each outer post with

a curtain crossway under the windows. There may be seven feet of window to three feet of pilaster in such a structure, yet it would be stronger than any structure in which the ends of the main timbers rest upon the wall.

When the objection is taken to making this wall of plank finished on the outside either with steel shingles, with tiles or with cement around and under the window frames, that the proposed material, plank, is more combustible than brick, one may ask where the critical point in a side wall is, when exposed to an outside fire. Does that outside fire go through the wall, or through the window?

I present this theory of a two-story frame mill, double glazed, completed and finished in all respects without any consideration of the material of which the window frame should consist. At the proper time that question may be taken up separately, and then decide what material should serve to hold the windows in place, keeping in mind the importance of so guarding the interior of the mill from the effect of outside changes in the weather as to make it very easy to maintain uniform conditions of temperature and humidity. This may be the theoretic cotton mill or worsted mill of the future; pure theory yet, as a whole, although each element proposed has been many times adopted by itself.

The PRESIDENT. I for one have listened to Mr. ATKINSON'S address with a great deal of interest. It comes home to us as manufacturers, who are the consumers of coal, and specially to those who are dependent wholly on steam power, as well as to others who have developed their water power to the fullest extent and who now use steam as an auxiliary. I have no doubt that this matter will be taken up at our next meeting, and that the board of government will consider it worthy to have the subject further discussed. We have our friends here from the other side of the water, and also a gentleman who represents the American system of automatic feeding, and if you would like to hear from them perhaps they will speak to us. For myself, I should be glad to do so; or, if you wish to ask Mr. ATKINSON any questions in regard to what he has said, you will now have an opportunity.

Mr. BIRKENHEAD. The interesting remarks of Mr. ATKINSON on boilers and automatic stokers recall to my mind that automatic stokers, in connection with the old wagon boilers, were in use in England up to the time of the invention of the tubular boiler. We can imagine what a large nest of boilers was necessary to make steam for a thirty-thousand-spindle mill, when fourteen pounds pressure was all they were safe to carry; and the immense quantity of coal burned to keep such a large quantity of water up to steam-making temperature, with the large amount of radiating surface. These boilers and stokers were arranged below the ground surface, so that coal could be dumped into the hoppers; at the bottom of the hoppers were two revolving cylinders, with projecting teeth, that crushed the lumps of coal, and the motion of these rolls could be varied to determine the quantity of coal needed. The coal that passed between these rolls dropped upon, or between, two flat disks with rising wings, which revolved rapidly in
directions, and threw the coal, as it dropped upon t
the surface of the grate bars. These stokers ca
saving in labor; but when the tubular boilers ca
carrying sixty pounds of steam, the improveme

have reached a limit, and the eagerness for these boilers was such that the labor-saving stoker seemed to be overlooked. As then constructed, it could not be applied to the new boilers. One would almost think, with the multiplicity of automatic machinery now in use, there could now be little use for the old-time muscle and shovel.

Mr. ATKINSON. That sprinkler system, so called, of automatic feeding, is practically played out. It has been tried and abandoned. The conveying system is now the accepted method.

The PRESIDENT. We shall be pleased to hear from Mr. HOWATSON.

Mr. HOWATSON. I have heard so much already that I feel that I can hardly say anything to interest this meeting. There is one thing that struck me forcibly here which I will mention, with regard to the question of boilers, which I noticed in one or two works which I visited. I do not call in question anything you do with the multitubular boilers, but those of that character which I saw here are all discarded in our mills. We use altogether the Lancashire style of boiler. They have an inside casing of water, not a casing of brick; so that the heat from the fire is taken up by the water and not by the brick, and on the point of economy we consider this a great saving; the horse-power obtained exceeds what can be got from the external fire type. In many cases, especially in London, where fuel has become very dear, the multitubular type of boiler has been discarded, and the Lancashire type put in. With regard to the use of fuel in London, there is a smoke-prevention act, the same as acts against any other nuisance or crime. For instance, the police there have power to go into a place and stop the smoke when they see a chimney smoking. Most manufacturers can comply with this act by using anthracite coal, but they have to pay as high as five dollars per ton; whereas with these machines of ours they can put up a boiler and use a coal which costs only three dollars a ton. The result has been to bring into consumption about fifteen thousand tons of small bituminous coal per week. It is a fact that our manufacturers

and engineers have discarded the tubular boilers and adopted the Lancashire type. I find here that you stick to the external fire tubular boiler, and do not seem to adopt the internal tubular fire boiler. I should like some explanation on that point from any of the gentlemen present, as I think it is a fact worthy of consideration.

The PRESIDENT. I will call on Mr. RONEY for a few remarks.

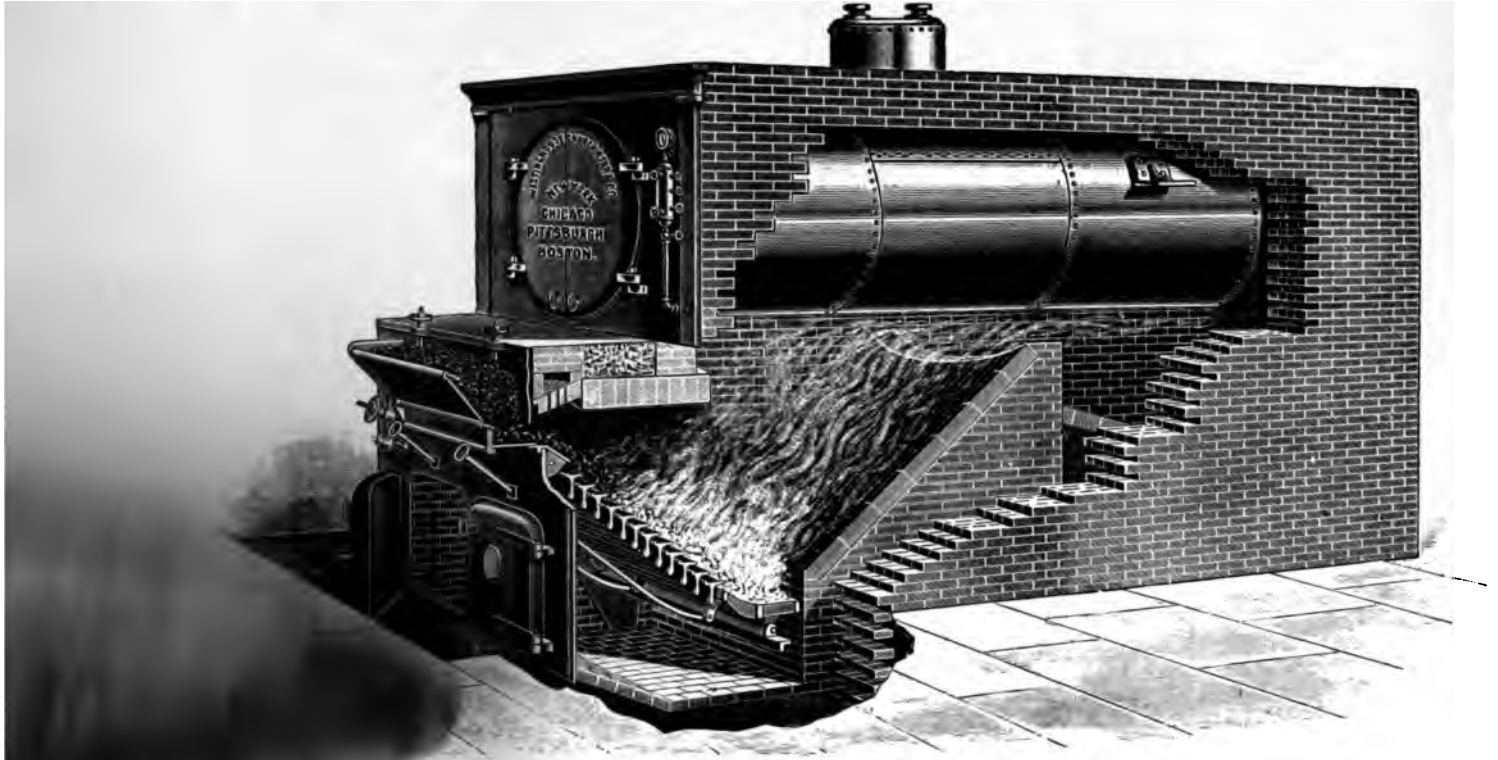
Mr. RONEY. I think it is hardly fair to pit two gentlemen representing the two sides of the ocean against each other. I am not a public speaker, and did not expect to be called upon for a speech. I have tried to do a little in the way of invention, and developing a more economical method of producing steam than the usual method of firing boilers by hand, and to enable steam users to turn out their product for the least possible fuel cost. Years ago when looking into this subject my attention was called to what was being done in mechanical stoking abroad, and we must give your English cousins credit for being the pioneers in this field. In investigating this subject I find that the first inventor of the mechanical stoker was Watt, the inventor of the steam engine, and from the first crude device which he used over one hundred years ago there has been continual progress down to the present time. While much credit is due the various forms of English stokers, still we find that in this country we must deal with very different conditions of boilers and fuels from what is met with abroad. In developing the idea of mechanical stoking, I have endeavored, taking American conditions, American fuels and American boilers, to develop a stoker which would give the greatest possible eva tion per pound of fuel with the least amount of labor for a ance and with the least injury to the boilers. I thor believe in mechanical stokers, and can shake hands with from either side of the water who is in favor of stoking; as I believe that when you can do away wastefulness of average hand-firing, you will get increased economy in fuel, but you will greatly le

life of the boilers, and will hear far less of those "mysterious explosions" due to careless firemen with their irregular firing and bad care of the boilers. In seeking after higher engine duty the boiler room has been too much neglected; so much so that it is not an uncommon sight to find a magnificent plant of engines taking steam from boilers which do not work within twenty-five per cent. of their possible economy. I believe that with mechanical stoking you can not only get a greater evaporation per pound of fuel, but will reduce greatly the chance of accidents. This is accomplished by the perfect combustion which is obtained through the uniform feeding of the fuel, and avoiding the continual opening of doors for firing and cleaning, which admits large quantities of cold air, interfering with the combustion, and injuring the boiler by the extreme changes in the temperature of the furnace. In other words, with a well-designed mechanical stoker, adapted to the types of boilers and kinds of fuel used, it is possible to get the greatest amount of duty from the coal with the least variation in the temperature of the furnace and with the least fluctuation in the steam pressure, not to mention the entire abatement of the smoke nuisance.

A few words in explanation of some of the stereopticon illustrations which Mr. Atkinson has given us to-day may be of interest, as showing the development of mechanical stoking together with mechanical handling of fuel and ashes, as it has been worked out in this country.

This American stoker was shown in a number of views, as applied to the ordinary horizontal return tubular boiler. One of these illustrates the stoker as applied to a single boiler (see Fig. 1), and shows the brickwork broken away so that the construction and operation of the stoker is plainly seen. This construction consists of horizontal overlapping grates, placed in steps which have a constant variable rocking motion. Coal is placed in a hopper on the front of the stoker, and by a constant steady feeding motion is supplied to the fire as desired. The quantity thus fed into the furnace is regulated at will by a small

Fig. 1.



The Roney Mechanical Stoker applied to a Return Tubular Boiler.

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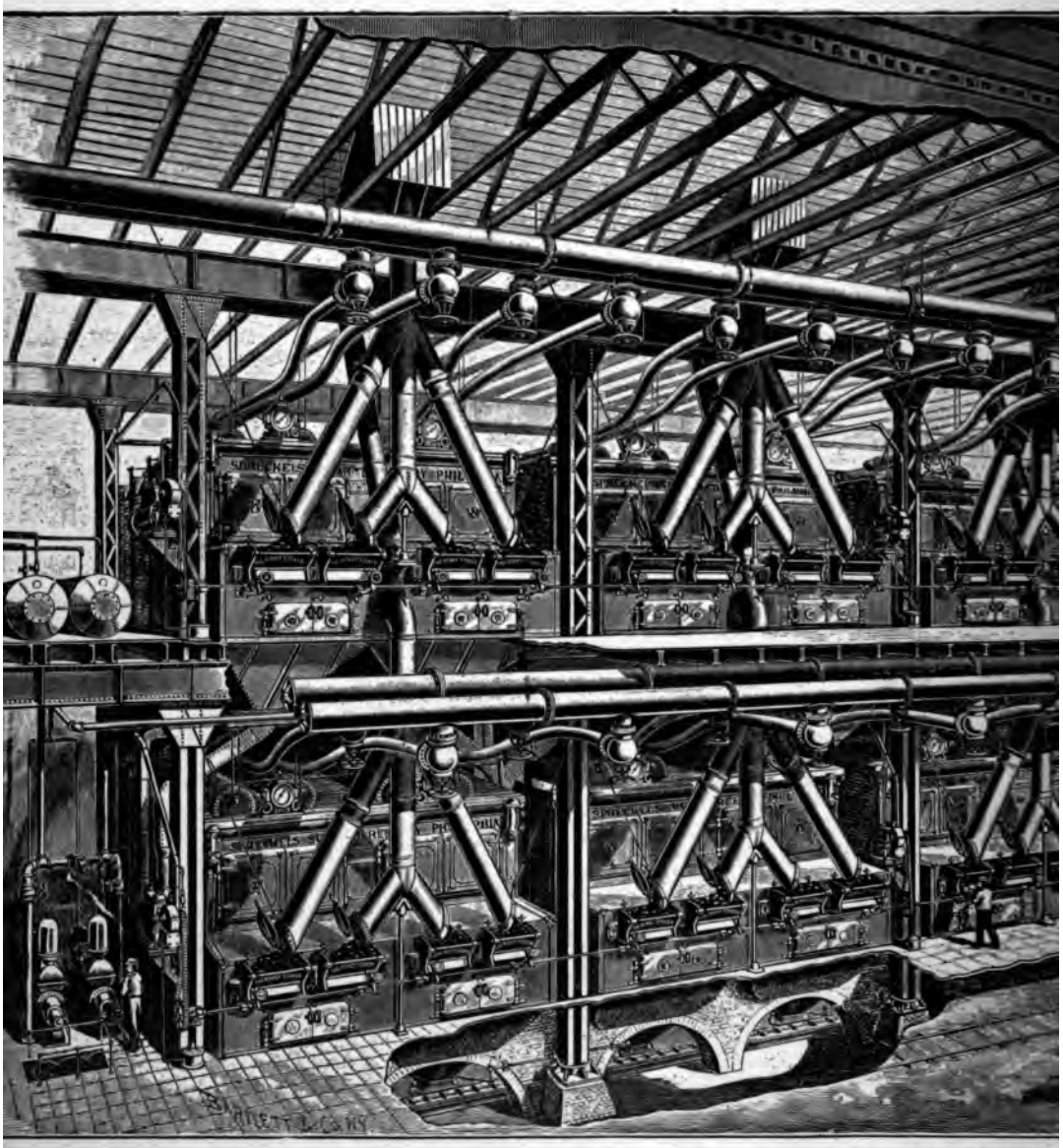
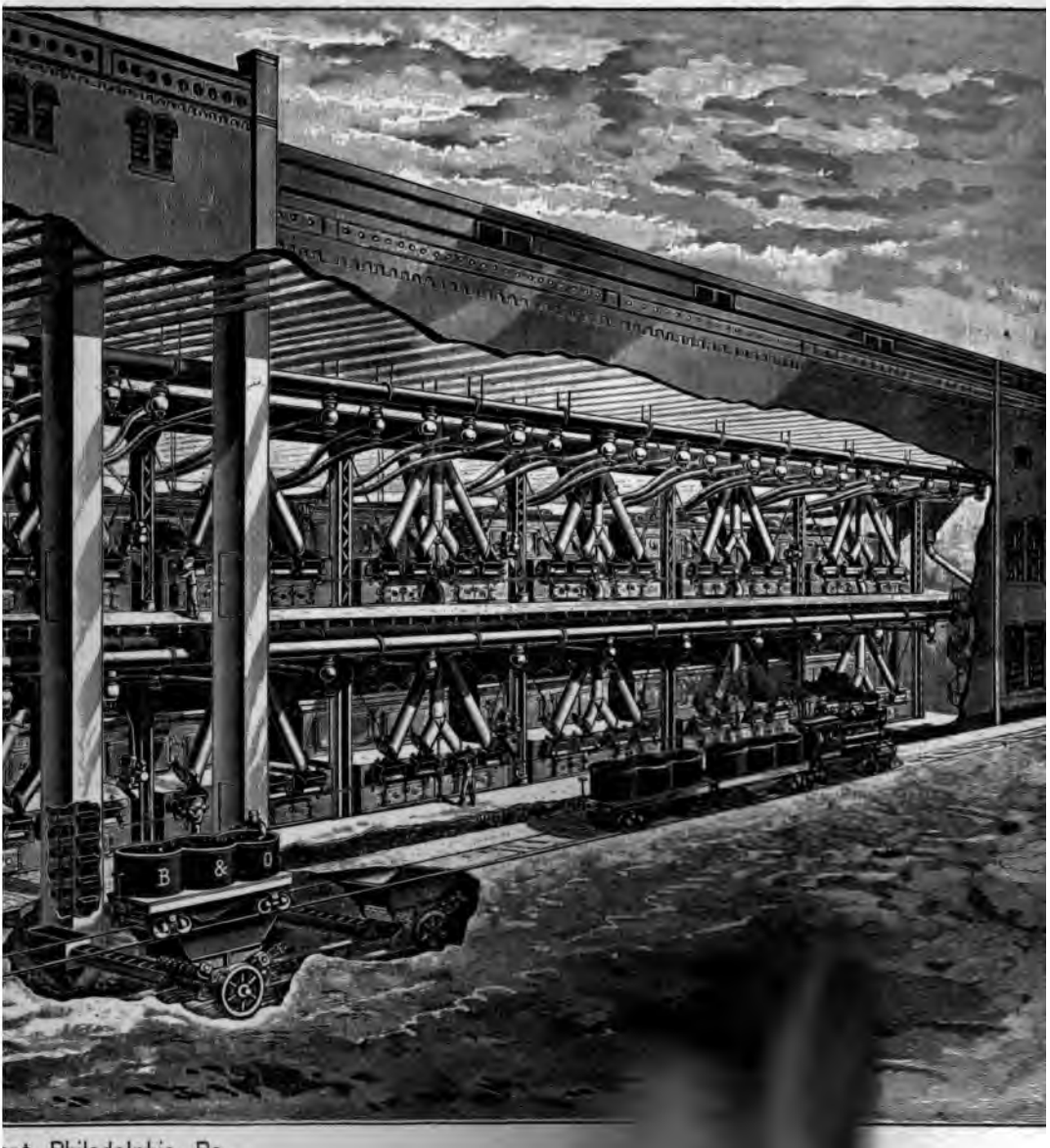


Spreckel's Steam S

Babcox & Wilcox Boilers equipped with Ro



ant, Philadelphia, Pa.

ers and Coal and Ash Handling Machinery.

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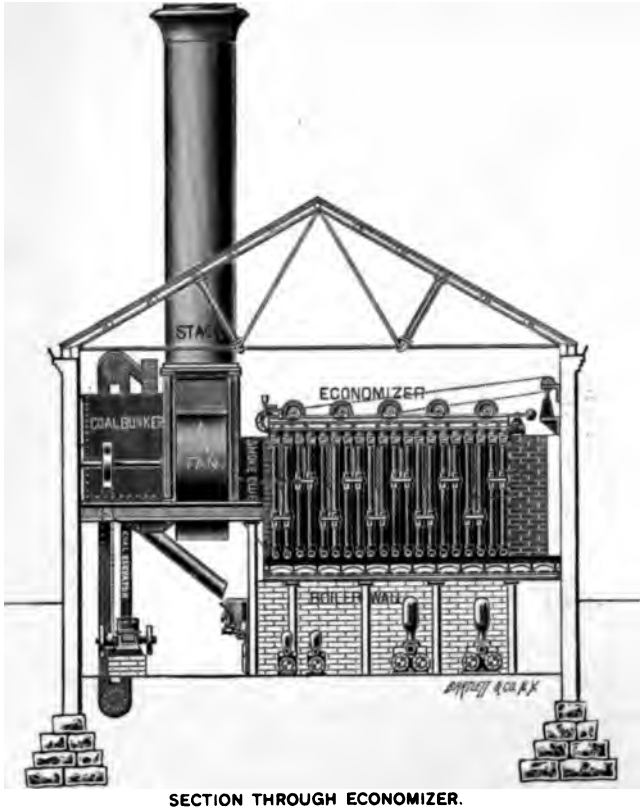
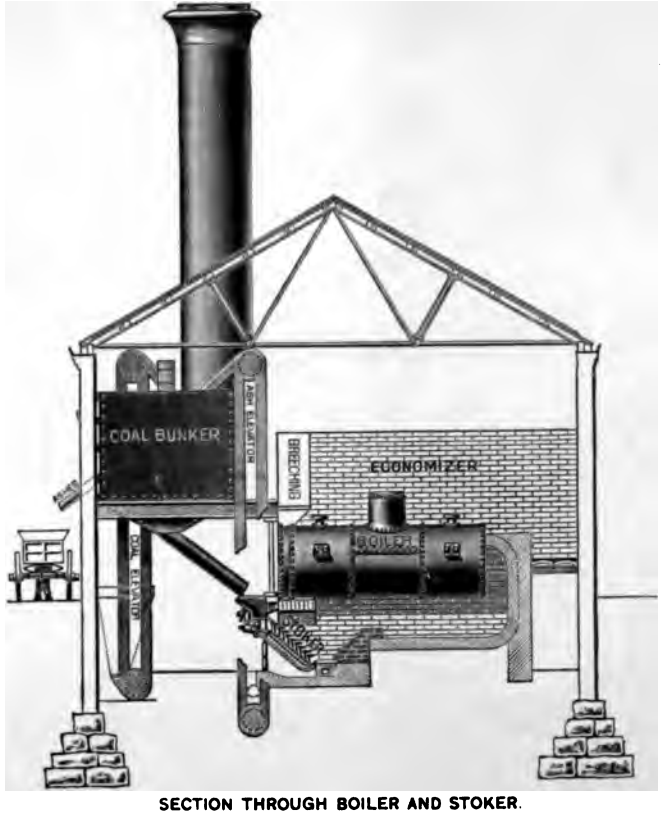
Fig. 5.



SECTION THROUGH ECONOMIZER.



SECTION THROUGH BOILER AND STOKER.

Boiler House, Curtis Davis & Co.

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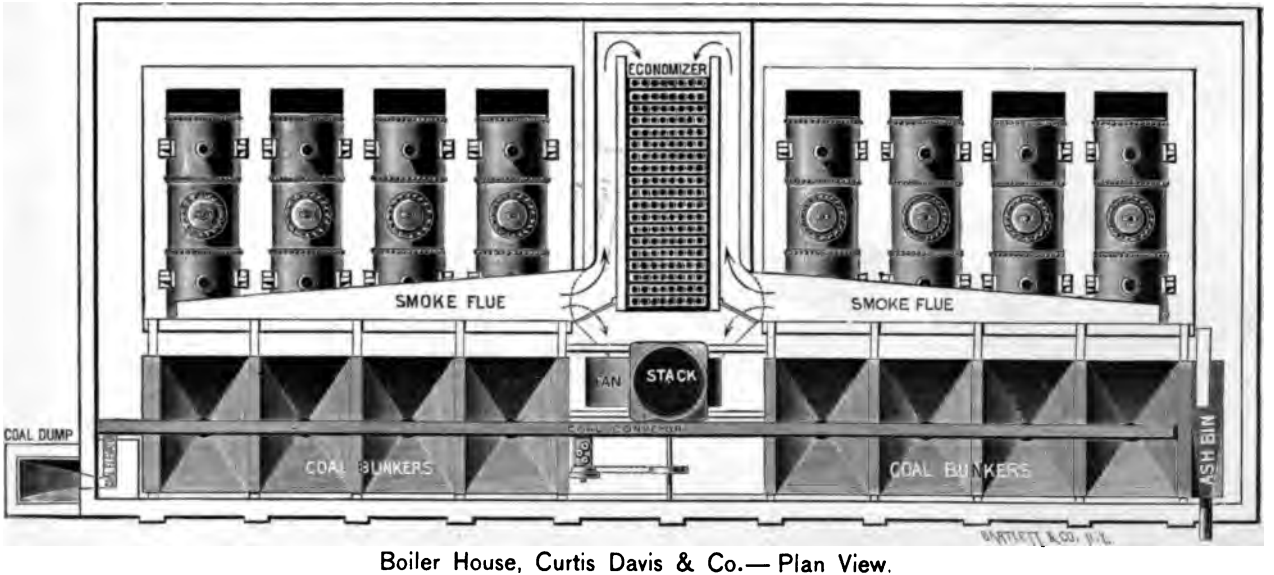
Fig. 4.



Boiler House, Curtis Davis & Co.— Plan View.

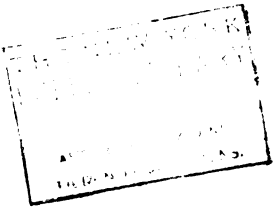
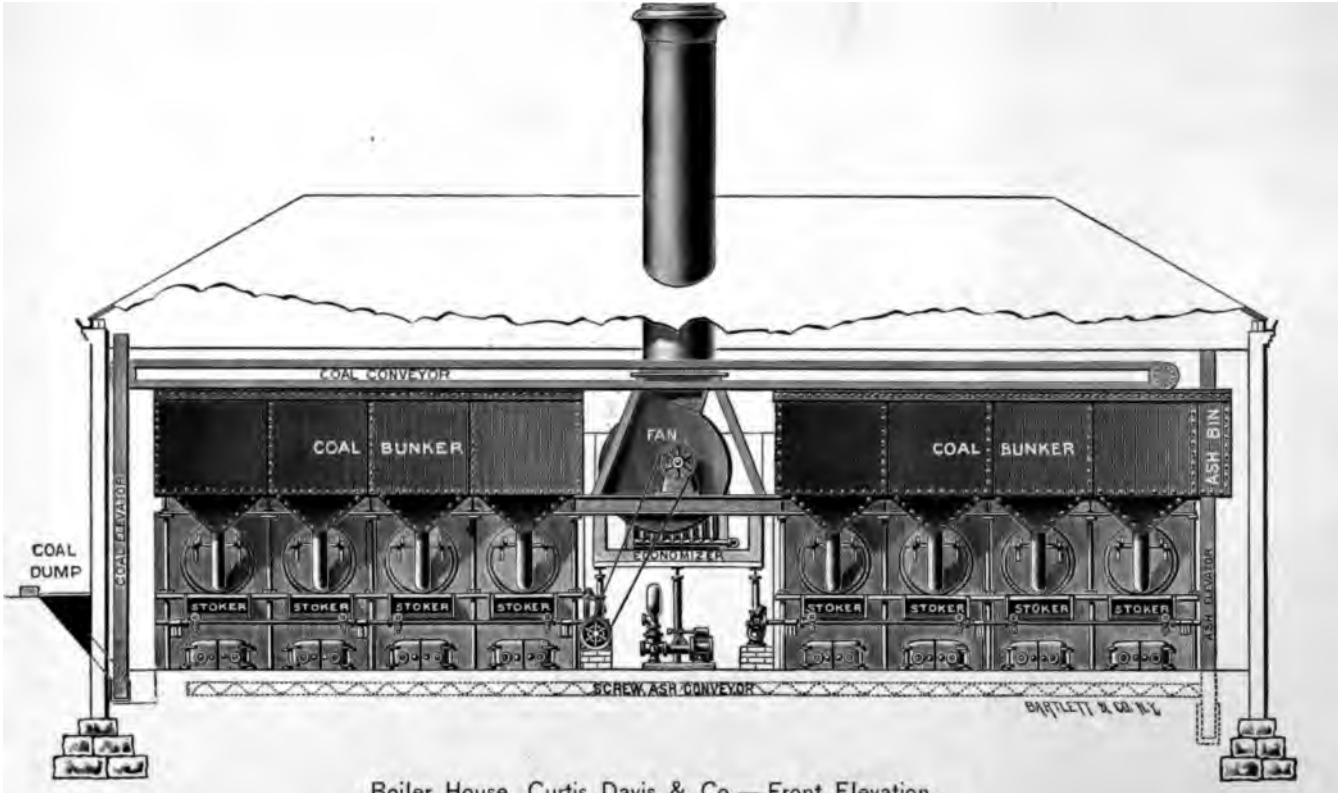


Fig. 3.



Boiler House, Curtis Davis & Co.—Front Elevation.

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Fig. 2.

Boiler House, Curtis Davis & Co., Cambridgeport, Mass.

hand wheel. The motion of the grates is also regulated by a pair of lock nuts on the connecting rod projecting through the front, and by the adjustment of the hand wheel and the lock nuts the quantity of fuel and the motion of the grates are regulated. These two simple adjustments are within the comprehension of the most ordinary firemen, and their simplicity illustrates the leading characteristic of the stoker in its entire construction. The stoker can be applied to boilers already in place with very little disturbance of the setting, as the side walls are not disturbed, merely the lower part of the front removed and the grate bars with their supports introduced into the space previously occupied by the flat grate setting.

A much more extended application of this stoker in connection with coal and ash handling machinery was shown us by Mr. Atkinson in a number of views of what can be justly styled "A modern boiler plant" (see Figs. 2, 3, 4, 5). It was designed and constructed for Messrs. Curtis Davis & Co., Cambridgeport, Mass., by Westinghouse, Church, Kerr & Co., engineers, Boston. This plant when completed will consist of eight return tubular boilers, of one hundred and twenty-five nominal horse-power each, built to carry a working pressure of one hundred and thirty pounds per square inch. The boilers are equipped with the Roney mechanical stoker and smokeless furnace, coal and ash handling machinery, economizer and mechanical draft, all so arranged as to produce the maximum amount of power with the minimum consumption of fuel and labor.

The fuel used is Pocahontas coal, delivered by carts, which dump it onto the grating at the end of the boiler house. The fine coal passes through and the large lumps are easily broken by the teamster, thus bringing it to a uniform size. Af r
the grating the coal is raised by a bucket elevator
veyer extending the entire length of the boiler ho
distributes it in the bunkers supported on i
front and above the boilers. From these b
flows by gravity through spouts to the sto

matically supply it to the furnace as required. The ashes from each boiler are taken by a screw conveyer underneath the floor to another elevator, which delivers them into an overhead ash bin, from which they are discharged into carts for removal. Thus, from the time the coal is dumped by the teamster until the ashes are discharged into the carts there is practically no manual labor required to handle coal or ashes.

In addition to the saving in labor, so perfectly does the mechanical stoker supply the proper amount of fuel and oxygen that absolutoly no smoke is produced; *not by burning it*, but *preventing it* by perfect combustion of the gases which are usually allowed to escape up the chimney, a source of loss to the manufacturer and a nuisance to his neighbors. The perfect combustion of the fuel is also shown by the fact that the ashes from a ton of coal are but a little over one half those produced from the same quantity of coal under hand-fired boilers at the same manufactory.

The hot waste gases from the boilers pass through an economizer, thereby utilizing the heat they contain to heat the feed water.

The necessary draft for the boilers is produced by a large, slow-running exhaust fan, discharging into a short iron stack placed immediately above it, and extending through the roof about twenty-five feet. The fan is driven by a small Westinghouse engine, having a pressure regulator attached to the steam pipe, for controlling the speed of engine and fan, so that they will run slow or fast, according as the steam pressure at the boiler varies. *This fan, with its twenty-five-foot stack, is capable of producing a draft pressure equal to that of a two-hundred-foot chimney costing ten times as much to build*, and is far more flexible in meeting sudden demands for steam.

The economy in labor and fuel obtainable from a plant of boilers thus equipped with stokers, economizers, coal and ash machinery and mechanical draft, will not only pay a handsome dividend on the investment, but will also greatly lengthen the life of the boilers, and reduce the possibility of accidents

due to the severe strains caused by the irregularity of hand-firing.

We were also shown a sectional-perspective view of the immense boiler house and steam plant at the Spreckel Sugar Refinery, Philadelphia (see folder). This plant consists of eight thousand horse-power Babcock and Wilcox boilers, placed in two batteries of four thousand horse-power each, one above the other, with the coal-storage bunker occupying the third story of the building. This entire battery of boilers is equipped with sixty Roney mechanical stokers, to which the coal is supplied by chutes from the storage overhead as fast as required. The coal is delivered by train load to the boiler house, and dumped into hoppers which supply two large coal crushers placed underneath the railroad track. The coal when broken to a uniform size is delivered by means of spiral conveyers to vertical bucket elevators, which deliver the coal into a horizontal conveyer, which distributes the coal the entire length of the coal bunker above the boilers. The ashes are also discharged by gravity through chutes to a conveyer placed in the cellar, which in turn discharges them into an elevator, from which they are delivered into an elevated ash bin, from which they flow by gravity into cars for removal; so that from the time the bottom of the coal cars are dumped there is no further handling of coal or ashes until they are delivered into cars for removal. So perfectly does the entire system work that one man with ease attends to two thousand horse-power boilers.

Mr. Barker. Mr. Howatson raised one question, which was, why the Americans use the multitubular type of boiler, while the Englishmen use the Lancashire type. I know of no one who is so well fitted to answer that question as M[illegible]omas J. Borden, and I should like to hear from him.

Mr. Borden. I suppose that Americans u[illegible]ntal tubular boilers extensively because the cost of [illegible]tion and repairs, for equal steam capacity, is le[illegible] of internally fired boilers of the English typ[illegible]h "Galloway," which is the chief represent[illegible] thus far in this country.

When using bituminous coal there is an advantage in the passage of the flame the full length of the boiler before entering the return tubes, thereby promoting complete combustion with a minimum discharge of smoke from the stack. With horizontal tubular boilers properly set and fired, bituminous coal can be used with almost no smoke. There are some internally fired boilers at the sewage pumping station at South Boston, which yield good results as to economy of fuel, but their cost was much greater than an equal capacity of horizontal tubular boilers.

Mr. JOHNSTON. I will state why I adopted the multitubular boiler. Many years ago we put in some hog-nosed boilers; we ran them six years, not economically, and then, in rearranging our steam plant, we discarded these and put in boilers with the internal fire arrangement, and after running them for seven years we discarded those and put in the multitubular boiler. The hog-nose was a long thirty-two-foot tubular boiler, with the fire underneath, with a consumption of four, we will say; the internal fire boiler, six feet in diameter and eighteen feet long, we will say has a consumption of six; the multitubular boiler, with the fire underneath, has a consumption of ten, four, six and ten. What is the reason we do not get a better result from the internal fire boiler? The fire box is inside the boiler, and there are four inches of water space around the ash box. The air and feed of the boiler passing over the whole surface of the ash box, the water is chilled; and you lose all the gain there is from having a fire inside the boiler.

Mr. ATKINSON referred to one fact, that when we got the improvements made we would have slow combustion, and we would therefore have great economy; I mean complete combustion.

Mr. JOHNSTON. I made a test of slow combustion, ten years ago, with a one hundred horse-power tubular boiler, fire underneath. With slow combustion, lowering the draught, the evaporation was 6.5; I increased the draught and the consumption of fuel for the boiler forty per cent., and the evaporation was 10.5 instead of 6.5.

Mr. Birkenhead. With soft coal how many feet from the furnace can you get a temperature of 212°?

Mr. Howatson. With our apparatus by which the smoke is prevented entirely, the gases going away from the fire at a higher temperature than the fire, we find back of the boiler a temperature of 212°. The heat is led round the boiler on one side and brought back again, and is taken up by the shell of the boiler.

Mr. Birkenhead. It would interest me, and I have no doubt the rest of the members, if some figures could be given as to the distance that heat will travel under or through a boiler from a furnace of anthracite coal compared with Cumberland coal, and also with a wood fire. I have noticed that hard coal, on account, perhaps, of its not carrying a flame, very soon loses its boiling temperature of 212°. If I am correct, is it not important that boilers should be constructed with this point in view, since in the case of a return-flue boiler the distance may be so great that the heat of the furnace may become in a measure absorbed before it has reached the chimney? If it should do so, would it not take away a portion of the heat it has just given?

Mr. Borden. The temperature directly under a horizontal tubular boiler, using either anthracite or bituminous coal, with boiler worked fairly up to its capacity, is rarely less than 700 to 800 degrees, and may be much more than 1,000 degrees. If carrying steam at 80 pounds' pressure, the temperature of which is about 324 degrees, exceedingly good results will be obtained if the temperature of the gases, after passing through the tubes, on discharge into the chimney, does not exceed 37[illegible] degrees. They are usually 400 to 500 degrees. Hence Birkenhead's enquiry as to the effect of a temperature than 212 degrees is not pertinent. Heat once gener travel under or through a boiler of a given type equal with equal diminution of temperature, whatever coal The loss, by absorption of the foundations, or rad surfaces exposed to the air, is no greater with anthr

with bituminous coal; but the distance the flame is permitted to travel before entering small tubes has much more effect upon the complete combustion of bituminous coal than upon anthracite. Hence the horizontal return tubular boiler admits of more thorough combustion of bituminous coal, and consequently less smoke, than most types of internally fired boilers.

A single horizontal tubular boiler presents a considerable external area of brick-work as a radiating surface; but several such boilers set together, as is usual in large steam plants, with the top of the setting well protected by a good non-conductor, lose comparatively little heat. In the use of anthracite coal very good results can be obtained from internally fired upright tubular boilers of the "Manning" or "Corliss" types, which also cost materially less than the "Galloway" boilers, and I think yield equally good results, if properly proportioned to the work expected of them. These boilers, however, have the lower tube sheet in too close proximity to the grates to admit of complete combustion of bituminous coal, the tendency being to smother the flame on its entrance to the tubes, and therefore to discharge more or less smoke, especially when fires are forced.

Mr. Birkenhead. It seems to me the boiler should be adapted to the coal or the coal to the boiler.

The President. We should be pleased to hear from Mr. Vicars.

Mr. Vicars. I have nothing to add to what my colleague has said. I thank you very much for your kind reception, and I hope when you come to England you will come to see us. We would like to return to you in some way what you have given to us to-day. I hope this mechanical stoker of ours will be taken up by you before the expiration of the period which Mr. Atkinson allows for his theories to materialize. Ten years is a long time to wait.

Adjourned.

[No. 54.]

N. E. COTTON MANUFACTURERS' ASSOCIATION.

PROCEEDINGS

OF THE

TWENTY-EIGHTH ANNUAL MEETING,

HELD AT BOSTON,

APRIL 26, 1893.

PRECEDED BY

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1893.

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Henry M. Wilcox	John Rhodes Warp Mill	Millbury, Mass.
Theop. W. Wilmarth		Saundersville, Mass.
Thomas Wilmarth	Saunders Cotton Mills	Saundersville, Mass.
A. S. Winslow	Crompton Co.	Crompton, R. I.
George Wood	Millville Manuf. Co.	Philadelphia, Penn.
C. J. H. Woodbury		Lynn, Mass.
Alvin Woodman	Jewett City Mills	Jewett City, Conn.

Honorary Member	1
Total number of Active Members	258

MEMBERS OF THE ASSOCIATION.

1893.

ARRANGED BY STATES.

MAINE.

Stephen I. Abbot	Lockwood Co.	Waterville.
A. D. Barker	Avon Manuf. Co.	Lewiston.
George W. Bean	Androscoggin Mills	Lewiston.
Robert Burgess	Portsmouth Co.	South Berwick.
Woodbury K. Dana	Banner Mill	Saccarappa.
R. W. Eaton	Cabot Manuf. Co.	Brunswick.
H. B. Estes	Continental Mills	Lewiston.
James G. Garland		Biddeford.
Samuel Hale	Portsmouth Co.	South Berwick.
Frank Haskell	Westbrook Manuf. Co.	Saccarappa.
William Hayes	Barker Mill	Auburn.
John M. Kimball	Westbrook Manuf. Co.	Westbrook.
Robert W. Lord		Kennebunk.
Robert McArthur	Pepperell & Laconia Cos.	Biddeford.
James H. McMullan		Biddeford.
Franklin Nourse	York Manuf. Co.	Saco.
William D. Pennell	Hill Manuf. Co.	Lewiston.
H. L. Pratt	Bates Manuf. Co.	Lewiston.
Roscoe C. Reynolds		Lewiston.
James A. Walsh	Lewiston Bleachery	Lewiston.

NEW HAMPSHIRE.

Stephen N. Bourne	Stark Mills	Manchester.
O. S. Brown	Salmon Falls Manuf. Co	Salmon Falls.
William D. Cadwell	Jackson Co.	Nashua.
George A. Clark	Manchester Mills	Manchester.
Fred. K. W. Ely	Columbian Manuf. Co.	Greenville.
Charles H. Fish	P. C. Cheney Co.	Manchester.
M. F. Foster		Milford.

William C. Greene	Columbian Manuf. Co.	Greenville.
John Holland	Cocheco Manuf. Co.	Dover.
David L. Jewell	China, Webs'r & Pemb'ke M.	Suncook.
D. W. Johnson	Monadnock Mills	Claremont.
George E. Kent	Pittsfield Mills	Pittsfield.
Hervey Kent	Exeter Manuf. Co.	Exeter.
Albert F. Knight	Amory Manuf. Co.	Manchester.
Charles H. Manning	Amoskeag Manuf. Co.	Manchester.
Charles D. McDuffie	Manchester Mills	Manchester.
E. H. Nutting	Hooksett Manuf. Co.	Hooksett.
Charles H. Plummer	Great Falls Manuf. Co.	Great Falls.
William I. Spear	Jackson Co.	Nashua.
Herman F. Straw	Amoskeag Manuf. Co.	Manchester.
Edmund E. Truesdell	China, Webs'r & Pemb'ke M.	Suncook.
T. B. Wattles	Boscawen Mills	Penacook.
George F. Whitten	Stark Mills	Manchester.

MASSACHUSETTS.

Alfred E. Adams	Whitinsville Cotton Mills	Whitinsville.
Edward Atkinson		Boston.
Edward W. Atkinson		Boston.
Edwin H. Baker	Otis Co.	Ware.
W. A. Barrell	Lawrence Duck Co.	Lawrence.
Lewis C. Bass		Boston.
Edwin N. Bartlett	Sigourney Mill	North Oxford.
John Birkenhead		Mansfield.
Nathaniel B. Borden	Barnard Manuf. Co.	Fall River.
Richard B. Borden	Troy C. & W. Manuf. Co.	Fall River.
Thomas J. Borden	American Print Works	Fall River.
Thomas S. Borden	Metacomet Mills	Fall River.
B. C. Brainard		South Hadley Falls.
Edward A. Brigham		Boston.
Edward N. Burke		Lowell.
Byron F. Card	New Bedford Manuf. Co.	New Bedford.
George A. Chace	Bourne Mills	Fall River.
Simeon B. Chase	King Philip Mills	Fall River.
Elbridge G. Childs	Mass. Cotton Mills	Lowell.
Jeremiah Clark		Lowell.
Alfred Clarke		Lowell.
F. E. Clarke		Lawrence.
Alonzo A. Coburn		Lowell.
J. G. Coburn		Newton.
John A. Collins	American Linen Co.	Fall River.
J. J. Connell	Cohannet Mills	Taunton.
Alphonso S. Covel	Tremont & Suffolk Mills	Boston.

A. G. Cumnock	Boott Cotton Mills	Lowell.
B. D. Davol		Fall River.
Chas. W. Dennett	Johnson Manuf. Co.	North Adams.
E. P. Dennis		Lowell.
Charles A. Denny		Leicester.
George Dexter	Pepperell & Laconia Cos.	Boston.
Eben S. Draper		Hopedale.
George A. Draper		Hopedale.
William F. Draper		Hopedale.
William F. Draper, Jr.		Hopedale.
John M. Dunham	Merrick Thread Co.	Holyoke.
David H. Dyer	Quequechan Mills	Fall River.
William Firth		Boston.
Herbert Fisher		Taunton.
William B. Fittz	West Boylston Manuf. Co.	West Boylston.
Frederick A. Flather		Newton Upper Falls
John Gegenheimer	Boston Duck Co.	Bondsville.
Charles E. Getchell	Boston Duck Co.	Bondsville.
William C. Godfrey	Indian Orchard Mills	Indian Orchard.
Alfred M. Goodale	Boston Manuf. Co.	Waltham.
Charles J. Goodwin	Indian Orchard Mills	Indian Orchard.
Stephen Greene		Boston.
Frank R. Hadley	Bennett Manuf. Co.	New Bedford.
Frank J. Hale		Newton Upper Falls.
William E. Hall	Lawrence Manuf. Co.	Lowell.
Z. D. Hall	Berkshire Cotton Manuf. Co.	Adams.
C. M. Harris, Jr.	Oakdale Shirt Manuf. Co.	Oakdale.
Henry F. Harris	West Boylston Manuf. Co.	Worcester.
James G. Hill	Lawrence Manuf. Co.	Lowell.
Chas. H. Hobbs	Thorndike Co.	Thorndike.
Gideon F. Holmes	Plymouth Cordage Co.	North Plymouth.
Geo. L. Hooper	Shaw Stocking Co.	Lowell.
William Hooper		Boston.
Henry S. Howe		Boston.
Roland R. Kelly	Williamstown Mfg. Co.	Williamstown.
William J. Kent	Wamsutta Mills	New Bedford.
Nath'l B. Kerr	Grinnell Manuf. Co.	New Bedford.
John Kilburn	Lawrence Manuf. Co.	Lowell.
Evan Arthur Leigh		Boston.
Ernest Lovering	Lyman Mills	Holyoke.
Henry M. Lovering	Whittenton Mills	Taunton.
Arthur H. Lowe		Fitchburg.
J. S. Ludlam	Merrimack Manuf. Co.	Lowell.
Alvin S. Lyon	Lowell Manuf. Co.	Lowell.
Charles T. Main		Boston.
Rufus A. Maxfield		Lowell.

Fred. C. McDuffie	Everett Mills	Lawrence.
William G. McLoon	Boston Manuf. Co.	Waltham.
John Tempest Meats		Taunton.
Timothy Merrick	Merrick Thread Co.	Holyoke.
James I. Milliken	Everett Mills	Lawrence.
Fred W. Moore	Cordis Mills	Millbury.
George F. Morgan	Tremont & Suffolk Mills	Lowell.
Albert H. Morton		Lowell.
Oliver H. Moulton	Hamilton Manuf. Co.	Lowell.
Frank J. Muir	Tremont & Suffolk Mills	Lowell.
Warren M. Orswell	Shirley Yarn Co.	Fitchburg.
Francis J. Parker	Monadnock Mills	Boston.
Walter E. Parker	Pacific Mills	Lawrence.
John W. Pead	Merrimack Mfg. Co.	Lowell.
Haven C. Perham		Lowell.
John M. Pevey		Lowell.
J. E. Prest		Whitinsville.
M. W. Quinn	Hamilton Woolen Co.	Amesbury.
T. G. Ramsdell	Monument Mills	Housatonic.
Robert Redford	Arlington Mills	Lawrence.
James Renfrew, Jr.	Renfrew Manuf. Co.	Adams.
F. H. Rice	Holbrook Mills	West Boylston.
Charles E. Riley		Boston.
Henry Saltonstall	Pacific Mills	Boston.
Arnold B. Sanford	Globe Yarn Mill	Fall River.
J. H. Sawyer	Newmarket Manuf. Co.	Boston.
Thomas C. Sheldon	Sawyer Mill	Boylston.
William F. Sherman	Atlantic Cotton Mills	Lawrence.
Charles M. Shove	Granite Mills	Fall River.
Francis H. Silsbee	Pacific Mills	Lawrence.
Arba C. Stater	Linwood Mills	Whitinsville.
William S. Southworth	Mass. Cotton Mills	Lowell.
Joseph Stone		Boston.
Geo. P. Taylor	Lancaster Mills	Clinton.
James W. Taylor	Eclipse & Beaver Mills	No. Adams.
Richard Thackeray	Weetamoe Mills	Fall River.
Earl A. Thissell		Florence.
E. W. Thomas	Tremont & Suffolk Mills	Lawrence.
James P. Tolman	Samson Cordage Works	Boston.
Geo. W. Towne	Arlington Mills	Lawrence.
Jude C. Wadleigh	Mass. Cotton Mills	Lowell.
James Waring	Narragansett Mills	Fall River.
J. W. Wattles		Canton.
George W. Weeks	Lancaster Mills	Clinton.
Channing Whitaker		Tyngsborough.
Harry T. Whitin	Rockdale Mill	Northbridge.

A. N. Whiting	L. M. Harris Manuf. Co.	Oakdale.
William S. Whitney		Fall River.
Theoph. W. Wilmarth		Saundersville.
Henry M. Wilcox	John Rhodes Warp Mill	Millbury.
Thomas Wilmarth	Saunders Cotton Mills	Saundersville.
C. J. H. Woodbury		Lynn.

RHODE ISLAND.

Charles T. Aldrich	Baltic Mills	Providence.
William Ames	Fletcher Manuf. Co.	Providence.
Abel T. Atherton		Pawtucket.
Truman Beckwith	Dyerville Manuf. Co.	Providence.
E. C. Bucklin	Interlaken Mills	Providence.
Frank B. Comins		Providence.
Andrew J. Currier	Albion Mills	Providence.
John W. Danielson	Quinebaug Co.	Providence.
James Dempsey	Dempsey Bleachery	Pawtucket.
William P. Dempsey	Dempsey Bleachery	Pawtucket.
Herbert R. Farnum	Bernon Manuf. Co.	Georgiaville.
William Gammell	Berkeley Co.	Providence.
D. W. Gray	Forestdale Manuf. Co.	Forestdale.
William B. Gowdey		Providence.
Frederick Grinnell		Providence.
Arthur H. Gulliver	Lonsdale Co.	Ashton.
John F. Hamlet	Manville Co.	Manville.
Frank Harris	Hamlet Mills	Woonsocket.
Alfred Hawkesworth	B. B. & R. Knight's Mill	Pontiac.
Elisha H. Howard	Harris Manuf. Co.	Providence.
W. E. Keach	Slatersville Mill	Slatersville.
Joseph H. Kendrick		Providence.
Jesse H. Knight	W. H. Pope's Cotton Mill	Enfield.
J. Colby Lewis	Centreville Cotton Mill	Centreville.
Charles W. Lippitt	Social Manuf. Co.	Providence.
Henry F. Lippitt	Globe Mill	Providence.
Charles R. Makepeace		Providence.
Ira J. Martin	Stafford Manuf. Co.	Pawtucket.
Thomas Mayor		Providence.
Thomas C. Powell		Providence.
Charles H. Savage	Manville Co.	Manville.
George E. Sherman	Valley Falls Co.	Valley Falls.
Edward P. Taft	Ponemah Mills	Providence.
Ariel C. Thomas	Clinton Manuf. Co.	Woonsocket.
Charles E. Thomas	Globe Mill	Woonsocket.
D. M. Thompson	Mills of B. B. & R. Knight	Providence.
John Waterman	Warren Manuf. Co.	Warren.

A. Tenny White	Manville Co.	Manville.
William Whittam, Jr.	The William Clark Co.	Westerly.
A. S Winslow	Crompton Co.	Crompton.

CONNECTICUT.

Joseph D. Aiken	Ponemah Mills	Taftville.
H. C. Atwood	Williamsville Manuf. Co.	Killingly.
James A. Atwood	Wauregan Manuf. Co.	Wauregan.
E. S. Boss	Willimantic Linen Co.	Willimantic
W. R. Burnham	Uncasville Manuf. Co.	Norwich.
Chauncey C. Chase	Attawaugan Mill	Killingly.
J. Andrew Cumstock	Uncasville Manuf. Co.	Uncasville.
John Eccles	Ponemah Mills	Taftville.
C. S. Frisbie	Attawaugan Mills	Attawaugan
A. J. Gardiner	Danielsonville Cotton Co.	Danielsonville.
George W. Holt, Jr.	Monohansett Manuf. Co.	Putnam.
W. S. Hume	Danielsonville Cotton Co.	Danielsonville.
William C. Jillson	Hop River Manuf. Co.	Willimantic.
Walter B. Knight	Bozrahville Manuf. Co.	Bozrahville.
Frank M. Messenger	Grosvenor Dale Co.	No. Grosvenor Dale.
Elmer E. Page	Shetucket Co.	Norwich.
Moses Pierce	Norwich Bleachery	Norwich.
John Scott	Willimantic Linen Co.	Willimantic.
Robert R. Smith	Greenwoods Co.	New Hartford.
James O. Sweet	Ashland Cotton Co.	Jewett City.
E. B. Wilbur	Pequot Mills	Montville.
Alvin Woodman	Jewett City Mills	Jewett City.

NEW YORK.

HONORARY MEMBER.

George Arms	New York City.

ACTIVE MEMBERS.

J. O. Hannum	Victory Mills	Saratoga.
David J. Johnston	Harmony Mills	Cohoes.
David S. Johnston		Cohoes.
William L. Lyall		New York City.
Henry F. Mansfield	Mohawk Valley Mills	Utica.
G. H. Sayward	Standard Yarn Co.	Oswego.

NEW JERSEY.

Philip H. Fowler	Gloucester Gingham Mills	Gloucester.
J. William Clark	Clark Thread Co.	Newark.
John K. Russell	Millville Manuf. Co.	Millville.
H. E. Walmesley	Clark Thread Co.	Newark.

PENNSYLVANIA.

Richard Garsed . . .	Wingohocking Mills . . .	Philadelphia.
J. H. A. Klauder		Philadelphia.
William E. McGill		Philadelphia.
S. S. Spencer	Conestoga Steam Mills . .	Lancaster.
William E. Trainer . .	Linwood Mills	Linwood Station.
George Wood	Millville Manuf. Co. . . .	Philadelphia.

DELAWARE.

William P. Bancroft		Wilmington.

MARYLAND.

James A. Gary		Baltimore.

VIRGINIA.

Osmon B. Tilton . .	Lynchburg Cotton Mills .	Lynchburg.

GEORGIA.

Albert G. Martin . .	Kincaid Manuf. Co. . . .	Griffin.
George R. Stearns . .	Riverside Mills	Augusta.

SOUTH CAROLINA.

Ellison A. Smyth . .	Pelzer Manuf. Co. . . .	Greenville.

MISSISSIPPI.

John Hopkinson . . .	Mississippi Mills	Wesson.

TEXAS.

Lawrence V. Elder . .	Galveston C. & W. Mills .	Galveston.

CANADA.

Harold Lawton . . .	Merchants' Manuf. Co. . .	Montreal.

NEW BRUNSWICK.

John H Parks . . .	New Brunsw'k Cotton Mills,	St. John.

ENGLAND.

George Ashworth		Manchester.

CHINA.

A. W. Danforth . .	Shanghai Cot. Cl'h Mill Co.	Shanghai.

RECAPITULATION.

Active Members.

Maine	20
New Hampshire	23
Massachusetts	125
Rhode Island	40
Connecticut	22
New York	6
New Jersey	4
Pennsylvania	6
Delaware	1
Maryland	1
Virginia	1
Georgia	2
South Carolina	1
Mississippi	1
Texas	1
Canada	1
New Brunswick	1
England	1
China	1
	258

CALL FOR MEETING.

NEW ENGLAND COTTON MANUFACTURERS' ASSOCIATION,
BOSTON, April 1, 1893.

DEAR SIR: —

The stated annual meeting of the Association will be held at the MASSACHUSETTS INSTITUTE OF TECHNOLOGY, *Boylston Street, Boston*, on

WEDNESDAY, APRIL 26, 1893, at ten o'clock A.M.,

for the choice of officers for the ensuing year, and the transaction of other appropriate business.

Upon the conclusion of the business of the meeting the following topics will be taken up for discussion; and the Board of Government takes pleasure in announcing, with each, the names of members who have consented to introduce them.

1. What is the best economy obtained from steam engines in cotton mills, with actual examples, and under varying conditions?

Mr. CHARLES H. MANNING, Manchester, N. H.

2. Moistening the air in cotton mills.

Mr. NATHANIEL B. KERR, New Bedford, Mass.

3. How may we establish a unit, or standard of comparison, of the power required to drive a full system of machinery for the manufacture of cotton cloth?

Mr. F. M. MESSENGER, North Grosvenor Dale, Mass.

4. Recent developments in the electric transmission of power.

Mr. C. J. H. WOODBURY, Lynn, Mass.

5. Metallic rolls; have they come to stay?

Mr. H. L. PRATT, Lewiston, Me.

6. The best method of heating a cotton mill.

Mr. CHAS. R. MAKEPEACE, Providence, R. I.

In addition to the foregoing, topics heretofore considered will still be in order; and the Board hopes that further information can be given upon several matters presented at the last meeting.

At the close of the morning session the Association will dine together. This dinner, as before, will be paid for from the treasury, and be free to all members.

By order of the Board of Government,

AMBROSE EASTMAN,
Secretary.

PROCEEDINGS.

Pursuant to the foregoing notice, the stated annual meeting of the Association was held at the Massachusetts Institute of Technology on Wednesday, April 26, 1893, at 10 o'clock A.M.

The President, Mr. ROBERT McARTHUR, occupied the chair. The call for the meeting was read by the Secretary.

The PRESIDENT then announced that the meeting was open for business; the first item of which was the election of officers for the ensuing year.

Mr. W. E. PARKER. The usual custom has been to appoint a committee, to retire and nominate a list of officers. I move that such committee be appointed, to consist of five members.

The motion was carried.

Mr. HERVEY KENT moved that the committee be appointed by the Chair, and his motion was carried, and the chairman appointed the following gentlemen as the committee: W. E. PARKER, HERVEY KENT, JOHN K. RUSSELL, WILLIAM F. DRAPER, Jr., and S. N. BOURNE.

The PRESIDENT. While the committee are out, we will proceed with the business of the meeting; and we will now listen to the reports of the Secretary and Treasurer.

These reports were accordingly presented.

On motion of Mr. LUDLAM, the reports were accepted by vote of the Association, and ordered to be placed on file.

The SECRETARY. The following nominations for memb ship have been recommended by the Board of Governm and await your action.

Messrs.	CHAUNCEY C. CHASE . .	Killingly, Conn.
	H. B. ESTES . . .	Lewiston, Me.
	ALFRED HAWKESWORTH . .	Pontiac, R. I.

Messrs.	GEO. E. JORDAN	Waltham, Mass.
	JOHN W. PEAD	Lowell, Mass.
	CHARLES H. SAVAGE	Manville, R. I.
	H. H. SHUMWAY	Fall River, Mass.
	ALBERT S. SWEET	Fall River, Mass.
	WILLIAM WHITTAM, Jr.	Westerly, R. I.
	ALVIN WOODMAN	Jewett City, Conn.

It was moved that the vote be taken upon the members proposed for election collectively, and the motion was carried; and all the members proposed were elected by vote of the Association.

The SECRETARY. I desire to submit the following letter from Mr. EDWARD ATKINSON: —

BOSTON, March 28, 1893.

AMBROSE EASTMAN, Esq., *Secretary*.

DEAR SIR: — I shall probably be absent from the next meeting of the Cotton Manufacturers' Association. I will therefore make the following report.

The number of returns which have come in to me in reply to the questions put upon the manufacture of steam is very small, quite insufficient for any complete analysis or general conclusion. So far as they go, I think they indicate the importance of the subject; that is, separating the manufacture of steam from the work to which it is applied, and determining the cost by the unit of water evaporated. So far as the returns show anything, they appear to indicate that this side of the question has received very little attention; that the cost varies very greatly, and the field is one which needs to be explored as thoroughly as the question of lubrication was covered by a former investigation; while it might happen that similar useful results would follow. It rests with the members to furnish the material on which a base line can be laid, if they choose to send in replies to the questions put to them.

Respectfully submitted, EDWARD ATKINSON.

Mr. GOODALE moved that the consideration of the first paper be taken up, without waiting for the report of the committee. His motion prevailed, and the President called upon Mr. CHARLES H. MANNING of Manchester, N. H., to present his paper.

WHAT IS THE BEST ECONOMY OBTAINED FROM STEAM ENGINES IN COTTON MILLS, WITH ACTUAL EXAMPLES AND UNDER VARYING CONDITIONS?

By Mr. Charles H. Manning.

This title is a very broad announcement of the subject assigned to me on to-day's programme, and I have had no time to prepare the five-hundred-page volume, illustrated, which would be required to fully present this subject. So I will only offer one small example of actual practice, which will occupy but a very few minutes of your time.

I have selected at random a set of cards taken from the engines of the Amoskeag West Side Mill, which stands some eight hundred feet from the boiler house, up on a hill, where it is impracticable to get injection water, as we need all the steam this engine would supply as exhaust steam in the dye house; it is carried (at about 11 pounds back pressure) across the river, about one thousand feet to the dye house. I have taken four cards at random, from some on my desk, and have figured them over to find what the cost per horse-power in coal is in that mill.

In figuring the horse-power of these cards separately, I fi it not as evenly divided as ordinarily in this engine, wh think was probably caused by the stopping of some dynamos about the time the cards were being taken.

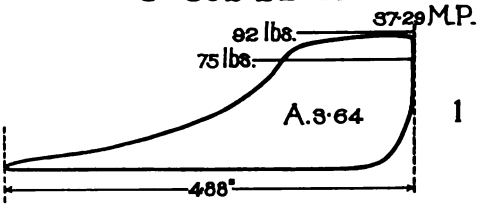
AMOSKEAG MILLS.

Engine No. 5 , Feb. 6th. 1893

C=392·22 HP.

Cylinder	South
Diameter of Cylinder	38
Length of Stroke	48
Position of Valve	Wide
Pressure of Steam in lbs.	92
Back Pressure in lbs.	11
Revolutions per minute	78

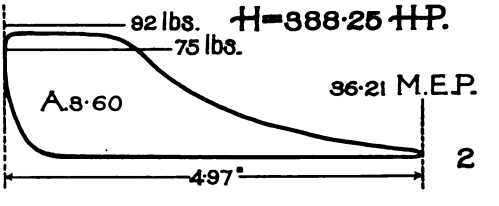
SCALE. 50.



H=388·25 HP.

Cylinder	South
Diameter of Cylinder	38
Length of Stroke	48
Position of Valve	Wide
Pressure of Steam in lbs	92
Back Pressure in lbs	11
Revolutions per minute	78

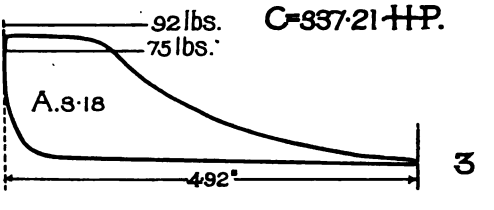
SCALE. 50



C=337·21 HP.

Cylinder	North
Diameter of Cylinder	38
Length of Stroke	48
Position of Valve	Wide
Pressure of Steam in lbs	92
Back Pressure in lbs.	11
Revolutions per minute	78

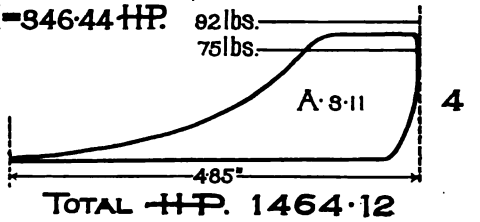
SCALE. 50.



H=346·44 HP.

Cylinder	North
Diameter of Cylinder	38
Length of Stroke	48
Position of Valve	Wide
Pressure of Steam in lbs.	92
Back Pressure in lbs.	11
Revolutions per minute	78

SCALE. 50.



TOTAL HP. 1464·12

In computing the steam received by the engine, I have taken the portion of the cylinder filled at seventy-five pounds gauge pressure, it being on the clearly defined expansion curve.

Cards taken Feb. 6, 1893: —

	Horse-power.	Portion of Cylinder filled with Steam at Seventy-five Pounds Gauge Pressure.
No. 1 crank end south cylinder,	392.22	.371
No. 2 head end south cylinder,	388.92	.321
No. 3 head end north cylinder,	346.44	.284
No. 4 crank end north cylinder,	337.21	.289
Total,	1,464.79	1.211

In computing the amount of steam delivered to the exhaust pipe, I have taken the volume of the cylinder up to the point of closing of the exhaust valve.

Portion of cylinder exhausted against 11 pounds back pressure: —

No. 1 card,	.840
No. 2 card,	.845
No. 3 card,	.853
No. 4 card,	.905
Total,	3.443*

	Square Inches.
Area of 38-inch diar piston,	1,134.118
½ area of 5¼ piston rod,	10.823
Average net area of piston,	1,123.288

$\frac{1{\cdot}123.288}{144} \times 4 = 31.2024$ cubic feet swept by piston per stroke.

$31.204 \times 1.211 = 37.786$ cubic feet of steam at 75 pounds pressure, accounted for by cards per revolution.

$\frac{37.786 \text{ cubic feet}}{4.831.1 \text{ cubic feet per pound}} = 7.82$ pounds per revolution at 75 per year.

$124.81 \times 3.443 = 429.72$ cubic feet rejected by the engine per revolution at 11 pounds.

* Cylinders full per revolution.

$\frac{429.72}{4 \times 15.39} = 6.95$ pounds rejected per revolution at 11 pounds pressure.

$\frac{7.82 \times 78 \times 60}{1.464.79 \text{ horse-power}} = 24.98$ pounds of water per hour per horse-power accounted for by cards as received.

$\frac{6.95 \times 78 \times 60}{1.464.79} = 22$ pounds of water accounted for by cards as exhausted against 11 pounds.

The cards account for 24.98 pounds of water received by the engine, and it is safe to say that this is 80 per cent. of water pumped to boiler, therefore $\frac{24.98}{80} = 31.22$ pounds of water per horse-power required by the boiler.

The exhaust steam had more heat in it when it was received in the engine; part of the heat of that steam has passed into waste, and the engine is chargeable with the heat which the steam has lost, and is to be credited with 22.2 pounds of steam at 11 pounds pressure per gauge; or, stated in other terms, 31.22 — 22.2 = 9.02 pounds of steam at 92 pounds gauge pressure, and the difference in the heat valve of 22.2 pounds of steam at 92 pounds and at 11 pounds.

At 92 pounds gauge pressure the total heat in steam above 32° is 1,182.95 units, and the average feed temperature of water supplied to boiler is 150°; therefore it will require 1,182.95 — (150.32) = 1,064.95 heat units per pound, or 1,064.95 × 9.02 = 9,605.84, for the portion of steam not accounted for in the exhaust.

The total heat at 11 pounds gauge pressure is 1,155.96, then 1,182.95–1,155.96 = 26.99 units of heat given up per pound of steam before exhausted and 26.99 × 22.2 = 599.178 heat units; therefore 9,605.84 + 599.18 = 10,205.02 total heat units expended per hour per horse-power.

With the type of boiler in use I have by test obtained 11,379 heat units per pound of coal burned, and this would make a horse-power cost $\frac{10,205}{11,379}$ .89 pounds of coal per hour.

It is safe to say the cost of running this mill is less than one pound of coal per horse-power per hour.

That is true as long as we have use for the exhaust steam,

but it is not absolutely true for the whole sixty hours a week that we run. Along about half-past eleven generally the work is shut off at the dye house, and there is a loss of exhaust steam, and the engine will go up to three pounds of coal per horse-power, two and a half or three. The same is true late in the afternoon; but there is a margin during the rest of the day inside of a pound of coal. So, taking the day through, if we should stop that mill it would reduce our coal expenditure in the boiler house less than 1,400 pounds an hour.

That I consider merely as one instance coming under the general head laid down in the programme, but not covering the whole announcement.

The PRESIDENT. Before proceeding with the discussion of this subject, we will listen to the report of the committee on nominations.

Mr. W. E. PARKER. The committee appointed to bring in nominations beg leave to report the following: For President, ROBERT MCARTHUR; Vice-Presidents, E. W. THOMAS, A. M. GOODALE; Directors, W. H. WHITIN, W. J. KENT, A. F. KNIGHT, F. C. MCDUFFIE, GEORGE W. BEAN, F. M. MESSENGER.

The PRESIDENT. You have heard the names of the persons nominated for officers for the ensuing year. I presume it will be necessary to vote by ballot.

Mr. W. F. DRAPER, Jr. I move that the Secretary be instructed to cast one ballot for the list of nominees brought in by your committee.

The PRESIDENT. If there is no objection, we will proceed in that way.

The SECRETARY. I cast one ballot in behalf of the Association for the list of officers as reported by the committee.

President MCARTHUR. I thank you most sincerely for this second manifestation of your favor, and I shall endeavor to serve you during the ensuing year to the best of my ability. I trust that the members of the Board of Directors, when they are called upon, which will be soon, to prepare topics for our next meeting, will respond promptly, and will not only appear, but will be prepared to present topics of interest for discussion.

We will now proceed with the discussion of the paper just read by Mr. MANNING.

Mr. W. E. PARKER. I shall be glad to hear from Mr. CHARLES T. MAIN, who, I think, has some facts of a kindred nature.

Mr. MAIN. Before the engine at the Lower Pacific Mills was changed, it was a cross-compound, with high-pressure

cylinder, 32 inches diameter; low-pressure cylinder 44 inches, and stroke, 72 inches. The ratio of areas of cylinders was 1 to 1.89; and they were so proportioned that a large amount of steam could be taken from the receiver for various heating purposes, for the dye house, wool-washing and other work about the mill.

We made a week's test under the actual running conditions. It was no gilt-edge test, but made to see just what the engine was doing under every-day conditions. We obtained the following results: The coal consumption per horse-power per hour during the running time was 2.37 pounds; and the total amount of coal used day and night, divided by the running hours, was 3.06 pounds per horse-power. Steam was taken from the receiver in varying amounts; the average amount throughout the week being 61 per cent.; that is, 61 per cent. was taken from the receiver, the remainder going through the low-pressure cylinder.

The boilers were not working very economically at the time of the test; and we afterwards put in an economizer which made a saving of about 14 per cent. Applying this saving to the results obtained in the test, the coal consumption during working hours would be 2.14 pounds per horse-power per hour, and the coal consumed during the 24 hours would be 2.63 pounds per horse-power per hour of working time.

The average indicated horse-power for the week was 1,037.

About one-half the coal consumption is chargeable to power; the other half is chargeable to dye house and other uses to which it is put. In this case, the coal chargeable to the engine would be just about one pound per hour per indicated horse-power during the running time.

Mr. Dana. Can Mr. Manning tell us the cost of steam, how much it costs per pound of steam in the dye house to dye a ton of yarn, or a hundred pounds of yarn?

Mr. Manning. It is hard to say; it depends a great deal on the amount of water in the yarn. A large part of our drying is of the raw stock of cotton; of the total weight, about 60

per cent. is water. It goes through the extractor, and the result is about 60 per cent. water and 40 per cent. cotton. Therefore, to obtain a pound of cotton dried you have got to evaporate a pound and a half of water. It will depend very much upon the atmosphere and the arrangement and condition of the drying room as to how much steam it will take to do that.

There is another expenditure that has got to come in; you have got to move the air around, because putting cotton into a room and simply raising the temperature, it will not dry, and there is more drying done by moving the air than by heating it.

Mr. DANA. I intended to have that cover the dyeing as well as the drying. I wanted to get at the facts to see how much it costs actually in the dye house to dye yarn.*

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* DEAN & MAIN, MECHANICAL AND MILL ENGINEERS,
EXCHANGE BUILDING, 53 STATE STREET,
BOSTON, MASS., April 27, 1893.

AMBROSE EASTMAN, Esq., *Secretary New England Cotton Manufacturers' Association, Boston, Mass.*

DEAR SIR: — At the meeting held yesterday the question was asked by one of the members as to how much coal was required to dye one pound of yarn. I made some tests in March, 1888, which included this question, and obtained the results as shown below. The system of dyeing was the short chain, dyeing various colors. The weight of coal was ascertained by having one boiler, a 60-inch horizontal tubular, set apart for this work alone, and weighing the coal to it.

	Coal Burned (Pounds).	Yarn Dyed (Pounds).					Average Count.	Pounds of Coal per Pound of Yarn.
		20s.	28s.	40s.	50s.	Total.		
First week,	23,918	3,168	16,225	-	3,850	23,243	30.55	1.03
Second week,	31,299	3,140	17,305	2,650	1,100	24,195	29.28	1.29

A portion of the difference between 1.29 and 1.03 pounds of coal per pound of yarn is accounted for by the fact that the dry cans run on an average two hours longer a day in the second than in the first week.

Very truly yours, CHAS. T. MAIN.

The PRESIDENT. I wish something might be said as to the cost per horse-power, or the consumption of coal per horse-power, in ordinary running; that is, of the compound triple expansion engine. I suppose Mr. MANNING can give us some figures.

Mr. MANNING. I cannot state very positively, nor refer to any cotton mill, because there are very few cotton mills that are arranged with triple expansion engines, and I have had no means of getting any reliable information as to what it does cost; but for running, as far as the engine is concerned (and the cotton mill engine should run as economically as any other), the triple expansion engine should be run on about 1.2 pounds of coal. The most economical compound engines show 1.4 pounds; so there is a leeway of one-fifth of a pound of coal per hour per horse-power; and whether that will pay for the large additional cost of the engine, the additional repairs and floor space covered, will depend chiefly on the price of coal. Where it is $5.00 or $6.00 a ton, undoubtedly it will pay to put in triple expansion engines; where coal is down to $3.50 a ton, it is a question that can be figured either way, according to the belief of the man who figures.

Mr. HANNUM. I would like to ask Mr. MANNING what pressure of steam he would propose to carry in order to get those results.

Mr. MANNING. The pressure of steam should be from 160 to 180 pounds. You can get as good results with a compound engine with two cylinders with 120 pounds as you can with three cylinders with that pressure. I know of experiments having been made with a triple engine where better results were obtained by throwing away the middle cylinder and making a compound engine of it. I don't think the trouble was in the triple engine, but in the design of that particular engine.

Mr. WARING. Do you know of a triple expansion engine

that runs with 1.2 pounds of coal per horse-power per hour anywhere?

Mr. MANNING. The only results that I know of are in the case of a triple expansion pumping engine; but where that was situated I cannot tell at this moment, as I have been reading so many tests on that question, at least thirty different ones, that I cannot distinguish them in my mind; but the best I have seen was the result of a pumping engine, which should give the best results of any, because the load is the most uniform load that it is possible to put on an engine. I cannot say where it was, but it was a triple expansion pumping engine, with automatic cut-offs on the first cylinder, only following right through from that, and running at 180 pounds initial pressure.

The PRESIDENT. We have read a great many times that these tests have been made with engines using a very small consumption of coal per horse-power, but I don't think in practice that the engines will come up to what the tests show. At our place we have been looking over this matter in a rough sort of way, and we have made some tests of our engines, but we cannot accomplish what others appear to do.

While it is well known that the compound engine of the Corliss, Wright or Greene type, of 500 horse-power and upwards, will produce one horse-power with the consumption of 1¾ pounds of coal, and the triple expansion engine with 1½ pounds, I think in order to include *all* coal used in starting and banking fires, and a sufficient allowance made for shortage in weights and waste in handling, and making no deduction for steam taken from the receiver for use in the mill, the amount to be charged to each engine should be, for the compound, 2 pounds per hour, and the triple expansion 1¾ pounds per hour.

This will give a full cost, for 305 days of 10⅓ hours each, and with Cumberland coal at $4.25 per ton of 2,240 pounds,

with the compound engine of $11.95, and the triple expansion of $10.46.

The labor cost of steam power in large mills using from two to three thousand horse-power from two or three engines, and steam from one boiler-room, and with full and regular load, — that is, a load not disturbed by the variations caused by running in connection with water wheels, — should not be much over $2.20 per horse-power per annum.

This includes *all* labor — coal passers, night firemen, chief engineer, and all extra work by engineer, firemen and mechanics on repairs and renewals on the whole steam plant. It is the custom at some mills to get considerable work done in the way of cleaning and repairing that does not appear on the pay-rolls of the power department.

With the same steam plant, and running in connection with water wheels and with a daily variation of 40 per cent. in the amount of steam power required, and a further variation of 80 per cent. at different seasons of the year, the labor cost may be $3.25 per horse-power per annum.

I have no doubt that with triple expansion engines, upright boilers and coal and ash handling machinery, the labor cost may be reduced to $2.00 per horse-power per annum.

The cost of supplies and repairs, which includes *everything* used in engine and boiler room and all bills for materials for repairs and renewals on the whole steam power plant, is 45 cents per horse-power per annum.

Experience in the case of the Corliss engine has been that the cost of repairs for the first twenty years is, or should be, very small, and the same being true of the boilers, the cost of supplies and repairs should be covered in this amount of 45 cents.

Then we have for the three engines the following summary of costs of 1 horse-power per annum : —

For the triple expansion engine, and favorable conditions in boiler room: —

For fuel,	$10.46	
Labor,	2.00	
Supplies and repairs,	.35	
Running expense,		$12.81
This plant costing $60 per horse-power, the charges against it would be		6.60
Cost per annum (1 horse-power),		$19.41

The compound, under favorable conditions: —

Fuel,	$11.95	
Labor,	2.20	
Supplies and repairs,	.45	
Running expense,		$14.60
Plant cost $50 per horse-power, charges,		5.50
Cost per annum,		$20.10

The compound, variable load: —

Fuel,	$11.95	
Labor, supplies and repairs,	3.80	
Running expense,		$15.75
Charges against plant,		5.50
Cost per annum,		$21.25

It was but a few years ago that we used to read about a horse-power costing $40, including the cost of plant; but we have reduced that about one-half, and I have no doubt that some steam plants are doing better than we are at Biddeford; but those figures I have given are taken from our pay roll, and everything in connection with the cost of the plant is included.

A Member. What is the best method of obtaining steam for drying, dyeing and heating purposes in connection with a

plant that is run by steam power; what is the most economical and best way of getting that steam?

The PRESIDENT. I wish I could answer that question. I am not conversant with dyeing or drying, but I presume some of the gentlemen here know considerable about it.

Mr. W. J. KENT. It seems to me that this is a different subject from the one we are discussing, and I move that we go on with the next paper. That might be a good subject for a paper for our next meeting.

A MEMBER. I will withdraw my question, if it is not proper for discussion under the paper.

The PRESIDENT. I was in hopes something more might be said about the cost of steam plant per horse-power; but if the members do not feel disposed to go on with that, we will take the next subject, "Moistening the air in cotton mills," by Mr. NATHANIEL B. KERR of New Bedford, Mass.

MOISTENING THE AIR IN COTTON MILLS.

By Mr. Nathaniel B. Kerr.

Mr. President: — In accepting the assignment to speak upon the subject of air moistening as applied to mills, I do not understand that I am expected to advocate any particular plan or method, now in vogue, of imparting or dispelling moisture. Indeed, were I called upon to recommend any particular style which I have used, I should be at a loss to know what to say, as my experience up to the present time has only had the effect of confusing my mind, and of rendering an impartial opinion almost impossible. One necessity we all recognize, and that is, even counts or numbers in our yarns, and a great deal of care is taken to obtain this. Quite an important factor in the matter, I think, and one that will stand considerable study, is the character of the atmosphere in the rooms where the yarns are made. Excessive dryness is sure to make itself manifest in a way familiar to us all. On the cards, drawing and speeders, the electrical effects are plain to be seen. The combs cannot take the cotton off the doffer. The fibres of the comber laps stand out bristling with defiance, and on the speeders and spinning frames it is difficult to get anything like a good quality of work. These effects, we are told, are due to the electricity in the atmosphere, superinduced by a lack of moisture. A high, dry temperature is not good either for the work or the help, and a great deal of attention has been given to this side of the subject, but it is difficult to see why

an excessively moist atmosphere is not just as troublesome. This will cause the weight of yarns to vary to such an extent that an extra amount of care and nursing is required to bring them out uniform, and, in spite of all the precautions that are usually taken, a very marked irregularity can be noticed every time a dry spell of weather is succeeded by a long moist spell. I presume this is due to the fact that cotton is an absorbent, and easily affected by moisture.

Now, these being the natural conditions under which we are obliged to labor, it follows that some artificial means must be employed to counteract the evil influences arising either from a lack or a superabundance of moisture.

The earliest method of imparting moisture of which I have any knowledge was the vapor pot, sometimes set into the floor, and sometimes attached to the posts of the mill. This style seemed to be mostly confined to the weaving rooms, and the rest of the mill was compelled to get along as best it could. Later the fog system was introduced, and applied to the other departments as well as to the weaving. I cannot say that I regard either of these systems as an unqualified success. Each has its points of superiority over the other. During the winter the steam vapor pot does its work with a higher degree of satisfaction to the operatives than in the summer, although I think there is prevalent a mistaken idea in regard to the amount of warmth added to the room by the vapor steam, for in reality there is a remarkable disappearance of heat when water is converted to vapor. I do not in the least believe that a foul condition of the air is necessary to ensure good w
nor have I ever been connected with a plant where che
(injurious to the health of the employees, and which
cause distress and sickness by being circulated throu
rooms) were used to preserve the boilers; but there is no
ing the fact that the air becomes heavy and oppressive
using vapor steam any length of time.

The aerophors, in my opinion, are chiefly valuable c

warm, dry weather, when they can be used to cool the air in the rooms as well as to give the necessary moisture. I have not found them of any service whatever during the six or eight weeks of foggy and dog-day weather with which New Bedford is favored every year. What we need there at that time is an apparatus that will take the already excessive dampness out of the air, instead of adding to it, and this neither the aerophor nor vapor pot will do.

Now right here steps in an agent of a blower system, and he says, "This is the way you long have sought, and mourned because you found it not," and when he has got through talking on the subject, we feel convinced that the proper thing has been discovered at last. He shows us that fresh air, either warm or cold, can be introduced at will into the different rooms. He also shows us how, by injecting a jet of steam or water into the air as it comes from the blower, we may distribute moisture in any quantity throughout the mill; but one thing he does not show us, and that is, how to control the air and moisture so as to answer the requirements of the several departments at the same time. Different kinds of work require different hydroscopic conditions, say as follows: a medium temperature and humidity in carding; a higher temperature and rather more humidity in spinning; and a high temperature with considerable moisture in weaving.

These conditions can only be obtained, so far as I know, by a combination of all three of the methods of which I have spoken, the vapor pot, the aerophor and the blower system.

The last named, I think, has greater possibilities for the future than either of the others, for I can imagine in a vague sort of way how this system can be applied so as to answer every condition and requirement of a cotton mill. It would be necessary of course to have pipes running from one or more common centres to the various departments, and also to different sections of each department. Into these individual pipes hot or cold air or moisture could be introduced, so that,

if one part of the mill required heat while another portion required cooling off and still another part called for moisture, all at the same time, the conditions could be met, and everybody made happy. Each pipe would be supplied with valves or dampers, and should be under the control of the overseers. There may be objections to this plan which I have not considered. I have never seen it in operation, although I have been told lately that there is a somewhat similar system being used in a mill in this State. It would be expensive to put in, and the pipes might be in the way after they were placed; but there surely would be a supply of fresh air coming into the rooms, forcing out the foul, impure air with which we are troubled, and which has always been a bone of contention. The humidity could be regulated to a nicety, and the trouble arising from the so-called dog-days would be a thing of the past.

Mr. F. M. MESSENGER. I don't think the blower system is as expensive as some others. A proposition was made to our company for moistening the air by the blower system, and I think that system was a little less than half the expense of the aerophor.

Mr. W. J. KENT. It may seem strange to the members of the Association who have heard the paper read by a manufacturer of New Bedford where the air is always just right; but, notwithstanding the fact, the three things which Mr. KERR presents have to be combined in New Bedford to manufacture cotton cloth successfully. I have yet to see an apparatus which will give us these results, and I hope that some one working in that direction will produce something before long to that end; as I shall be in the market.

Mr. C. J. H. WOODBURY. In the matter of school-house ventilation, we have put into some of the school-houses of Lynn, where I happen to be a chairman of the school committee, a method of forced ventilation, by which the air comes from the outside, and is heated by steam coils at the base of flues running to each room. There is a mixing damper at the base of each flue, controlled by a chain in the school-room, and the teacher can in that way entirely regulate the heat of the school-room by pulling this chain from one position to another, and altering the ratio of incoming air from the temperature of that passing among the steam pipes to that of the outside temperature, but the volume of air circulating through the school-room, at the rate of 125,000 cubic feet per hour, cannot be changed.

In this arrangement there is a provision for moistening the air by arrangements for injecting a small amount of steam at the bottom of the ventilating flues. It seems to me that it is far easier to add water to the atmosphere than to dry it. I don't think I have seen any methods attempted for removing water from the air in damp weather, though I have often

thought that, in connection with the blower system of ventilation, it might be possible to dry the air by means of lime, if the change would be worth the cost of doing it. There are various kinds of apparatus for removing moisture thrown out in dry rooms, by means of a coil of pipes with a solution of brine passing through them, cooled by volatilization of liquefied ammonia or some other refrigerating method, and the condensation is carried away in the form of water.

Mr. ROBERT R. SMITH. In the Greenwoods Company's mill in Connecticut we have had considerable experience in moistening the air to counteract the effects of electricity. It seems sometimes as if about all the electricity in New England came over the hill on the north-west of our mill, and for a time would stop the work entirely. We have tried many devices for this purpose, — steam, with hose, dampening pot, etc. The first apparatus used was made by Mr. GARLAND of Biddeford. I think we have had it in our brick mill for ten or twelve years, and I can speak very favorably indeed of it. It has enabled us to do our work a great many mornings in winter time, when we should have suffered great loss in product without it or some similar device. The next apparatus we had was the aerophor system, which was put into our old frame mill, and in order to get a circulation of the moist air, small fans driven by power were placed in the bottom of the aerophors, forcing the air out and through different channels left open in the apparatus for the purpose. These worked very well, but there was considerable trouble in getting at, and taking apart, the rose heads and taking out sponges and springs. It was considerable trouble keep them clean; also the fans, which ran rapidly, bec worn in their bearings. We adopted afterwards a diff apparatus of the same manufacturer, the Aerophor Com that has spreading wings; and which you have seen trated in the "Journal of Commerce" and other devoted to textile fabrics. Our men about the pr

were at a loss what name to apply to them; but finally called them "angels' wings." These angels' wings were taken to the upper story of our mill, which is much higher than the others, and they disseminate moisture; making the work go easier, the hands happier and the air cooler. This apparatus has worked *very satisfactorily*. For the lower stories we adopted a different process, and put in this apparatus which I have here, which was introduced by Mr. WALLACE, and perhaps he will speak for it himself.

Mr. WALLACE. I should like to have you describe it.

(A section of two Atomizers, in the room, was first put into operation and used in illustration.)

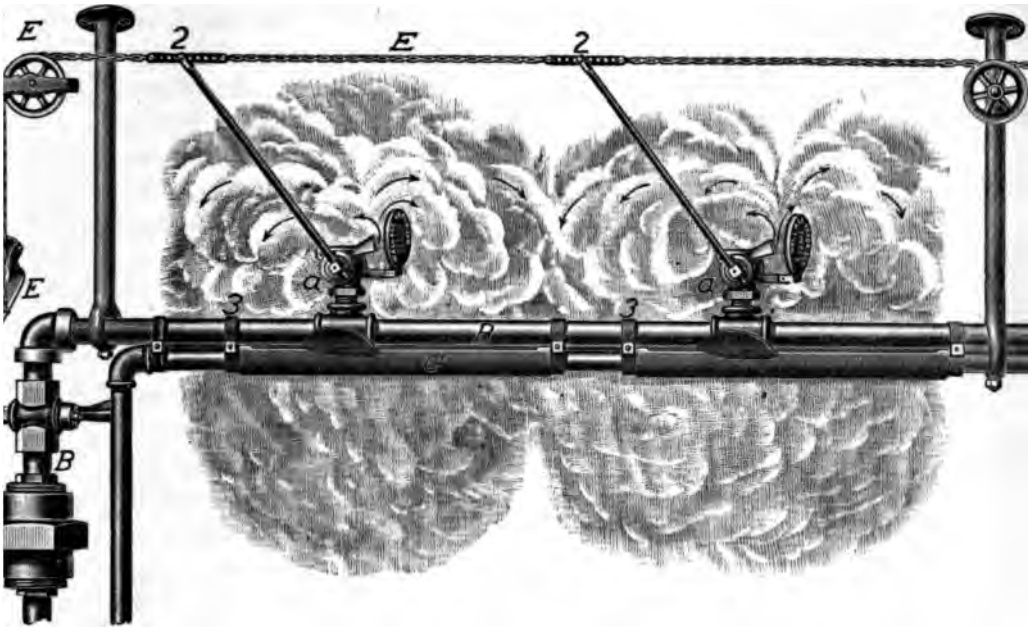
Mr. SMITH. Mr. WALLACE's design is to run the supply pipe from the town or city pressure, or from a pump. We put in a horizontal pump. This pipe (indicating on the Atomizer) runs through and supplies these heads here, which you can locate to suit the height of your mill. This chain is hitched at the end of the mill, and you can open the valves and give more or less moisture, as you choose. We first used the chain; but some of these orifices in the valve would get stopped up more than others, and they would discharge their moisture unequally; and then, owing to the draft of air in the room, the moisture would condense and come down on the floor and on the machinery; and so we have discarded the chain. Most of our weavers keep a stick by the side of their looms for measuring the width of the cloth; and with that stick they reach up and close or open these valves as necessity requires; and so each weaver at a set of looms can regulate the moisture to suit himself or herself, as the case may be. I have taken pains to observe how nearly these employees, who are simply weavers, would regulate the moisture for their work. Hardly ever do I pass through the mill and find these valves shut off entirely. Sometimes

A PRINT AND DESCRIPTION OF

WM. V. WALLACE'S

GRADUATED VALVE

AIR · MOISTENER · AND · COOLER.



THIS Valve is substantially made of non-corrosive gun metal, and is worked by **ordinary water pressure alone,** and may be **screwed to a T or 3-8 opening in a water pipe** anywhere. A 3-4 inch water pipe may run the length of a room, over an aisle, with T's reduced to 3-8, placed where vapor heads — valves — are needed. *a, a.* Automatic valves of non-corrosive bronze, 10 to 20 feet apart. *B, B.* 3-4 inch galvanized iron cold water supply pipe. *C, C.* 1-2 inch plain iron return pipe and fixtures. *E, E, E.* A steel safety chain attached to the arms which rock the valves, and passes over pulleys at either end of the line, being weighted at the right and hook[illegible] [illegible]e left. Unhook it, and let the weight slightly turn all of the valves, and [illegible] [illegible]ease the flow of the vapor. The reverse motion diminishes it, thus me[illegible] [illegible] ments of atmospheric changes. 2, 2. Bessemer steel arms and j[illegible] the valves. *G.* End of room.

The fitting of a room is plain piper's work. The water [illegible] are connected and pitch 1 inch in 20 feet to the left that t[illegible] discharged.

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TILDEN FOUNDATIONS

I would go through when they were at dinner, and shut them all off, and come in after dinner and find them all open. They feel the difference in their work, at once. This advantage of having moist air in the mill you all understand. This little valve (pointing it out) has a thread cut upon it similar to a letter V; and as the stem is turned, one way or the other, the opening for the passage of water is opened or closed. This part we have discarded, for fear the pipe would get stopped up. These little wings here (pointing), under the spray valve, were not large enough, and sometimes the moisture would be too much in one place and condense, and twenty feet from there the moisture would not condense; and so we have put in larger wings, here, to catch the condensation. These are different from the aerophor or the GARLAND system, for the reason that, if you desire it in any particular spot, you can run a pipe from it to where you want it, and you have your moisture.

Two heads of the moistening apparatus were placed in the office, where we are troubled with dry air, and we have found them to be a great comfort, not only for the physical condition, but also preventing our papers and books from becoming so parched and dry. As to the merits of these different apparatus for moistening the air, we should hardly be prepared to say that any one possessed all the merits, but that all had good features. The size of the mill, and the height between the stories, and other conditions, would enter into consideration as to which one of the different processes we should use. The particular feature of the WALLACE process is that it is portable, and can be placed in any location where there is room to put an inch wrought-iron pipe; and also the
very accessible and not subject to stoppages from
sediment that is more or less present in the water
be used for such purposes; for the reason that
be opened and a flush given, which, unless
very tenacious, will clean the small crevices

Mr. W. J. KENT. I am glad to hear that Mr. SMITH's help are so harmonious, and run the temperature so nicely. If we had that kind of apparatus in our mill, and allowed the help to tamper with it, we should have to keep sixteen policemen to regulate them. Have you any rule about the humidity or temperature in different rooms?

Mr. SMITH. In the Greenwoods Company's mill at New Hartford we have quite a number of different kinds of apparatus for testing or indicating the quantity of moisture in the atmosphere; most of which have found their way on the shelf, for the reason that it has not been found necessary to have any rigid rules in regard to their use. The overseer and help seem to understand, or know intuitively, when there is sufficient moisture in the air; the warps seeming to be a better indicator than any of the so-called hygrodeiks. The atomizers are opened and closed as necessity requires; being better indicated by the running of the work, and the feeling of the help, than by any apparatus that we have thus far been able to secure.

Mr. S. N. BOURNE. We have one room fixed up in that way, but we have not had the trouble that Mr. SMITH tells about. We have used the apparatus only for a few months. They are all connected with a chain, and they don't need any angels' wings.

Mr. SMITH. That was the other apparatus.

Mr. BOURNE. The room I put this arrangement into is used for spinning. Before, we had trouble with electricity; but since we have introduced this arrangement the electricity gives us no trouble. If one gets stopped up, a little pulling up of the chain once or twice seems to work out the obstruction; but very seldom we have to do that. As far as we have used it we are very much pleased with it. I have ordered some more, but the man who furnished this is one of those slow fellows, and we have not got them yet. There is one advantage about it, and that is, we have not any pumps to

take care of. We used to have the GARLAND system, but it was too much work to keep it in order. This system we now have does not seem to be any trouble, there is so little of it, and I wonder it was not thought of before, so simple a thing as it is.

A MEMBER. Where do you take your water from?

Mr. BOURNE. From the city; we don't get it from the Amoskeag.

Mr. BAKER. I had not intended to speak of the very simple system we have in one of our mills at Ware, but I may add a suggestion with regard to the blower system. In our weaving mill, with two floors, we have been experimenting for a few weeks with the blower system, and I think it will be successful, both with reference to introducing fresh air and also a sufficient degree of moisture for weaving. The plan is exceedingly simple: we have a small brick chamber in the basement, and, in connection with that, use the blower, introducing pure air into this chamber, and also water through a perforated pipe, to mingle with the current of air through a perforated pipe, regulating the amount of water introduced with an ordinary valve; and then conduct it to the weaving room through a simple galvanized-iron pipe, reducing the size of the pipe as it extends through different parts of the room, having small openings with iron dampers, so it can be regulated at different points where a current may need to be regulated. It is very simple and somewhat crude at present during this experimental stage, but as a means of introducing pure air for the benefit of the operatives and a sufficient degree of moisture it affords a very simple and I think succes method. It has not so far progressed that we can very positively of its success, but I think the indic are sufficient to lead us to suppose that it will accon both the features spoken of in this discussion.

Mr. W. J. KENT. I wish Mr. GOODALE would expl system he has in operation.

Mr. GOODALE. I can substantiate what Mr. BAKER has said. We use the blower system in one of our mills. In the air duct I put in a perforated pipe, the perforations being as fine as I could make them. This perforated pipe is supplied with water from a tank in the attic. The air from this duct comes up through pilasters on the north side of the mill, and is introduced into each room with the result that the humidity in the weaving rooms varies from 70 to 75. It helps us materially in the weaving, and the expense is very trifling.

Mr. MESSENGER. Do you use cold water?

Mr. GOODALE. Cold water and pressure.

Mr. A. F. KNIGHT. How do you cool the water?

Mr. GOODALE. We have a box in front of the blower which can be filled with cheap ice which can be used to cool the air of the rooms above.

Mr. GULLIVER. I should like to ask a question in regard to the amount of humidity required for different numbers of yarn, whether members have found it necessary to have a higher degree of humidity, as the yarn grows finer; and also whether the same humidity should be maintained in the mule room as in the spinning room?

Mr. W. E. PARKER. If I understand Mr. BAKER correctly, I should think Mr. GOODALE's method the best one. I understand that Mr. BAKER moistens the air before it is heated. Am I correct?

Mr. BAKER. No. We introduce a steam jet into the same room where we moisten the air.

Mr. PARKER. The method I have employed with the blower system has been to introduce a water and a steam pipe into the air duct which conveys the air to the mill. Heated air will carry a greater amount of moisture than cold air. I think it is better to introduce the moisture after the air is heated. We have both water and steam in our air duct.

Mr. BAKER. It was in following out that theory that we

thought it well to introduce steam at the very point of taking moisture into the air; introducing the two at that point, and we have found the result seems to vindicate that theory; the air does carry in this heated form a large amount of moisture. What we hope to do when the warm weather comes on is to keep the windows of the weaving mill closed, and use the water in as cold a form as we can get it, and to reduce the temperature inside the mill somewhat lower than it will be outside, with the windows closed; and at the same time we are giving the employees fresh air from the outside constantly and discharging the foul air from the room.

Mr. MESSENGER. We have five different systems in our mills, and we are now negotiating for a larger one to operate on four floors of the largest mill. We have always operated on the weaving with an independent apparatus from that used in the spinning and carding. We introduce this cold water under pressure, and, differing from Mr. GOODALE, with a pump. We introduce our water under a pressure of 45 pounds, that vaporises the water very fine; but, for weaving purposes, we cannot raise the humidity enough without introducing steam. In putting in our four systems we let the engines exhaust back of the fan, and introduce water jets front of the fan; in this way getting the humidity high enough for weaving purposes. We have not been able to obtain a sufficiently high humidity with water alone.

Mr. W. J, KENT. How high a humidity do you require?

Mr. MESSENGER. The instrument we use, a German instrument, we bought of Thomas Hall; and we adjust it occasionally by the dry and wet bulb thermometer. We calculate to carry 75 as the humidity; that is, the air is 75 per cent. of saturation.

Mr. KENT. I should like to ask of Mr. BAKER if in his appliance he has any arrangement to draw out the air already in the room, or is it merely forced out by the air that blows in?

Mr. BAKER. The air is forced out by the air that enters

the room. A slight indication of that would always be discovered at the door.

Mr. A. F. KNIGHT. Which is the better way to ventilate a room, — to force air into the room, or suck it out? I would like to hear from Mr. PARKER about that.

Mr. PARKER. I want to suggest, with all respect to the members, that when they ask questions, if they would give their own opinions, it would make the meeting more interesting.

Mr. KNIGHT. I have not had much experience, but I have an opinion.

Mr. PARKER. I have used a Sturtevant blower for heating two mills for several years, and I have always supposed that the best way of ventilating was to force the air into the rooms; and, as Mr. BAKER has said, you do get a slight pressure in the room, and the air will find its way out through the cracks round the windows and doors, any place where there is an opening; and you may at once infer that the heat in a room so heated is uniform throughout; at the upper part of the room you will find the temperature to be almost the same as on the floor, and that is one of the advantages of this method of heating. We have used fans for exhausting the air from rooms heated by the operation of machinery. I am not sure that it would not be better to force cold air into such rooms.

Mr. EATON. I am anxious to hear Article No. V, but I don't see much chance of getting to it. I move that we proceed to the next article.

The PRESIDENT. While I think this subject is far from being exhausted, perhaps it would be well to pass on to the next one; so, if there is no objection, we will take up the third topic, "How may we establish a unit or standard of comparison of the power required to drive a full system of machinery for the manufacture of cotton cloth?" by Mr. F. M. MESSENGER.

Mr. MESSENGER. I sent a letter to the Secretary, saying I had been unable to complete my paper, and could not present it to-day. I found it was a question requiring considerable data to make it interesting; and after I commenced, I did not have time to complete it. I hope to have it prepared for another meeting.

The SECRETARY. I received a letter from Mr. MESSENGER, but as he was here I thought he could make his explanation orally.

The PRESIDENT. The Secretary presented the letter to me, but, knowing that wise men often change their minds, I didn't know but Mr. MESSENGER would be prepared to-day. However, we will excuse him, and hope he will be ready at the next meeting, as I have no doubt the Board of Government will request him to present his paper then.

We will now take up the fourth topic, "Recent developments in the electrical transmission of power," by Mr. C. J. H. WOODBURY of Lynn.

RECENT DEVELOPMENTS IN THE ELECTRICAL TRANSMISSION OF POWER.

By C. J. H. Woodbury, Lynn, Mass.

Since the last meeting of this Association, the Board of Government, recognizing the importance to the cotton manufacturing interests of questions pertaining to the electrical transmission of power, and foreseeing the greater importance which this method is likely to assume, have thought it advisable to continue the consideration of this subject at the present meeting; and in accordance with their invitation I beg to deviate somewhat from my former papers on electrical subjects, and, instead of confining myself entirely to practical results, to give a little attention to some of the main principles involved, which will soon be as necessary a part of the knowledge of every manufacturer as the principles involved in water wheels and steam engines are at the present time.

In the ordinary dynamo for electric lighting, each of the various coils of wire making up a section of the armature is brought into the circuit as its commutator bar comes in contact with the brush, and in that manner contributes to the circuit for electric lighting or power the current of electricity which it has produced by being pulled across the attraction of the magnets of the dynamo.

In the reverse manner, if electricity were applied to such a dynamo, it would energize the magnets, pass through the wires of the armature, and the attraction of the magnets would cause this armature to revolve, or convert the dynamo into a

motor, because the magnet attracts each coil of the armature, and as it moves around in proximity to the poles of the magnet, the electricity is switched out of such coils by the commutator, and the magnet exerts no further attraction upon that coil, but is ready to exercise a similar attraction for the next section; for it must be remembered that the attraction which the magnet exerts is not upon the wires of the armature, for they are made of copper, but upon the current of electricity conveyed by these wires. A current of electricity is subject to magnetic attraction similar to iron, as may be seen by applying a magnet to a lighted incandescent lamp. The carbon filament is readily bent, as if it were a very fine iron wire, but if the lamp is not lighted, the carbon filament is not affected by the magnet.

The question naturally arises, Why should not iron or steel wires be used in the armature? The one sufficient reason is that the magnets would attract a section of wire in the armature, and would hold it stationary; whereas, when the attraction is exerted upon a current of electricity in the coil of wire in the armature, that principle can be used to produce a motion by the ready manner in which the electricity can be conducted through or removed from any coil of iron in the armature to meet the mechanical necessities of the case to produce a rotation of this armature.

I have gone into this matter at some length in order to state the principle of the ordinary continuous-current motors, which is that the magnet remains stationary, and that the electrical currents are moved from one set of wires to another in the armature as occasion requires.

In a dynamo the electricity is generated in the armature in currents passing to and fro, first in one direction and then in the other, forming what is known as the alternating current. The function of the commutator and brushes in a dynamo is merely to convert this alternating current into a continuous current. There is no reason why an alternating current is

not just as well suited for electric lighting as a continuous current. But many years ago, when Sir FREDERIC SIEMENS, one of the pioneers in the applications of electricity, made a system of arc lighting, requiring a continuous current to operate the regulator in the upper part of his arc lamps, instead of trying to invent a form of regulator to feed the carbons which could be operated by an alternating current, he placed the commutator and brushes on the dynamo, producing a continuous current, and in that manner set for years the practice of electric lighting by continuous currents, although in the mean time there have been numerous devices for regulating the carbon-feeding mechanisms of arc lamps by alternating currents.

Electricians have of late years begun at the place from which they were diverted a number of years ago to investigate and apply alternating currents for lighting and power purposes. These investigations have opened up a wealth of electrical principles and applications of which the world has just seen the beginning. One of these new forms of alternating currents is what is called the multiphase current, of which the electricity is generated in waves,—one wave following another before the first wave has been completed, using currents of electricity which will affect other apparatus by induction through space and without the intervention of metallic conductors, being as a matter of principle comparable to the results produced upon a telephone system when it receives by induction the noise of electric motors or the click of the messages transmitted along telegraph wires in juxtaposition to the telephone wires, or even the voice which is transmitted over other telephone wires.

In its application to these multiphase motors I would say that the method of construction differs entirely from the motors hitherto in use. Instead of using commutator and brushes to transfer electricity from one part of the armature to the other, as has been already alluded to in the continuous-

current motors, the magnetism revolves through the magnet, causing the armature to revolve in exact synchronism with it.

For purposes of comparison, the general arrangement of these motors may be compared to that of a hat brim, as representing the circular magnet, and a ball of twine stands for the armature, on the inside of which is a suitably wound collection of insulated wires joined together at the ends and not electrically connected to anything else. Electric wires from the generators are wound upon this circular magnet, and the wave-like currents which the wires carry produce similar magnetization travelling around and around through the magnet; and by this inductive effect to which I made allusion, electric currents are produced in the wires of the armature, so that it will be susceptible to the attraction of the magnet. The wires in the armature revolve, following the attraction of the magnetism circulating in the magnet.

Dynamos similar in principle produce the waves of current which supply this motor; but, for economy in transmission, both as regards the small amount of wire and the small loss by resistance, these currents can be generated at a high electrical pressure, which is increased by transformers for the main wires, and then at the motors reduced to a very low pressure by transformers, which answer the same purpose as the reducing valve for steam, except that they can act in either direction to increase or reduce the electrical pressure.

The other advantages of these multiphase motors are that, being without any brushes or commutators, there is no sparking. There is hardly a possibility of a burned armature. The motor, being operated by a succession of wave currents, will keep at a speed comparable to that of the generator as long as it can keep up. If overloaded, it will not run
but will stop. Under similar conditions of overl
continuous-current motor will burn its armat
defended by its safety fuses. Its regulation is ve
variability of some tests being only one and one-

between no load and its full load. Such a motor will start under its full load, or even greater.

In connection with such a system of electrical transmission of power, it is feasible to use a portion of the current for incandescent lighting without any interference. These motors can be stopped and started without the exercise of any particular skill, and can be enclosed for protection against dust and dirt in a case which merely allows for the protrusion of the shafting carrying the driving pulley.

These types of motors, although new, have received thorough applications and exhaustive tests in the works of the electric companies engaged in their manufacture. It is, however, scarcely time for their use in commercial lines in this country, but they will be very fully exhibited at Chicago.

It is this type of electrical apparatus which will be used in transmitting the power from Sewall's Falls on the Merrimack River, about four miles north of Concord, for power and lighting throughout the city of Concord, and also to any establishments which may be built on the large tract of land in the vicinity owned by that company. There is a capacity of 5,000 horse-power at this point, and it is expected that 3,500 horse-power will be distributed during the early summer.

The uses of electric motors in connection with the transmission of power is becoming more widely extended, one of the best examples in this vicinity being that of the Page Belting Company, at Concord, N. H., where the power is distributed throughout their extensive new establishment by means of electric motors, for which the electricity is generated in the original works of this company. Mr. George F. Page, the president, informs me that the whole cost of the electrical apparatus was twenty per cent. less than would have been required for a steam plant applied in the usual manner. There is a further economy by reason of the elimination of much of the shafting required in connection with the transmission of power from numerous motors, in comparison with

the shafting and pulleys which would have been required to distribute the power from a steam engine on the premises. The largest shafting now in these works is two and one-half inches in diameter; but if an engine had been used, the main shafting would necessarily have been at least five inches in diameter, and the length of shafting many times greater than at present, the difference in this respect being greater than in cotton manufacturing, on account of the greater distance between the various machines. In addition to safety and convenience, it may be interesting to note that this method of transmission has been carried out in such a way that there is not a single open hole through the floor for any purpose whatsoever, the openings for the steam pipes being packed around with asbestos. This transmission of the power from the old works is only temporary, as it is proposed to connect with the electrical power derived from the water wheels at Sewall's Falls as soon as that installation is completed.

I have been informed that at a new cotton mill in South Carolina the power will be transmitted by wire to a motor driving the line shafting in each room.

One of the latest applications of the electrical transmission of power is in the Crocker-Wheeler Electrical Works, at Ampere, N. J., where a pair of copper rods answer as line shafting, and from them the connections are made at will to motors operating machine tools in various parts of the establishment. In some instances it has been preferable to drive short lines of shafting by motors, and to belt down in the usual way. In the former case the motor is attached directly to the machine, as, for example, under the headstock of a l[illegible]d in place of using the cone pulleys for variation the clutch for reversing the direction of the mo[illegible] is controlled by the operator in a manner [illegible] usual way in which the motorneer of a st[illegible] speed or direction of the car; and from every machine an incandescent lamp st[illegible]

guards is used whenever artificial light is necessary, and such a light can be placed on the carriage, or wherever it may be desirable to apply the light for the purpose of the work in hand.

The operation of a calico-printing machine probably presents the greatest difficulties in the application of power of any machinery in textile manufacture. The machine must be driven at will with variable speed, and any shock in the gradations from one speed to another may impair either the machine or the product. The cloth must be moved at times to a slight extent, and the whole must be absolutely under the control of the operator. As an absolute statement, these requirements are almost an ideality. Up to the present time a double-cylinder steam engine to each printing machine has furnished the best method of driving, notwithstanding that the heat and the floor area occupied by the steam engine is necessarily an interference in the printing room. When the printing machine stops, the rolls sink into the blanket, and it requires an excess of power to start it, as if it were a heavily loaded team on a soft road.

A recent application of electric motors has given practical results of the greatest importance in operating printing machines at the Dunnell Print Works in Pawtucket. At the time of their reconstruction after their late fire, in accordance with plans made by STEPHEN GREENE, C. E., a member of this Association, about two years ago, Mr. W. W. DUNNELL, wishing that the new print works should contain all of the improvements possible in the business, considered favorably the suggestion that electric motors should be tried for the operation of printing machines. A motor was applied to a seven-roll printing machine, in order to give the matter a thorough trial. This work was undertaken in spite of the skepticism of his associates and the opposition of the men engaged in the printing room. There were some difficulties at first, primarily owing to the fact that the electricians were not calico printers, as well as that the printers were not electricians. It required a little time for each to learn of the other;

but since the several modifications in the arrangement for this work were introduced, the operation of the system has been not merely satisfactory, but has given results in advance of any other method of driving a printing machine.

In the electric lighting station of the works an Edison lighting dynamo with a separate exciter is used for generating a current to drive a motor which was placed on the unused portion, next to the rail, of the mezzanine floor, or what is known in the printing room as the "platform." It is entirely controlled by a hand wheel and switch at the front of the printing machine. This device has had a practical trial of eighteen months' duration, with the most satisfactory results. By its uniformity in rotation the cloth is printed at very much greater speed than with the steam engines in the same room. The driving is under absolute control. The cloth can be moved at will for a short distance, as an inch, if necessary. There is an absolute gradation of speed from one velocity to another, and that without any shock. These changes are so uniform that the doctor never cuts into the copper roll. The speed can be kept uniform at any desired velocity, and the machine can be stopped and started by anybody working at it. In its operation it does not require the exercise of any technical skill.

I have alluded to the maximum speed as being much greater than with any other method of driving printing machines. The uniformity of its motion can be seen by anyone watching the machine, particularly in the absence of the chattering of the gears. All printing machines are necessarily still for changing of rolls and other purposes a portion of the time, but the whole production of this mac is over thirty-three and one-third per cent. greater tha of the machines driven by steam. When it is consider a print works plant is worth more than $50,000 per m the value of a device which will increase the out- third is sufficient to introduce radical change in th manufacturing.

Mr. DUNNELL stated to me that his experience as shown by this trial has revealed such facts in regard to the capacity and capability of the electrical transmission of power for print works, that, if one were to begin anew the construction of such works, he should advise, instead of the numerous steam engines about the premises, the generation of all the power at a central source, and its transmission throughout the establishment by electricity.

This use of motors for the operation of printing machines is the first practical instance of its kind, and its adoption and persistent and faithful trial confirms the enterprise of Mr. DUNNELL, and also reflects great credit upon the practical skill of Mr. SYDNEY B. PAINE, the manager of the mill power department of the General Electric Company, notwithstanding that his modesty prompts him to disclaim the whole solution of the problem in which he was the moving spirit, and ask for due credit to his able coadjutors.

The whole tendency of later invention in regard to electric motors appears to be in the successful use of large motors. The Baltimore & Ohio Railroad are to use three one hundred and twenty ton electric locomotives for carrying the trains in the tunnels under the city of Baltimore, being able in that manner to perform the same service in traction as with the largest locomotives, and without producing any smoke to interfere with the air in the tunnel. In connection with these locomotives is a supplementary motor, which produces an air pressure for the air brakes and also for the whistle.

The advantages of electrical transmission of power are largely those of the relation of the position of the machinery with the motive power of the establishment. Each room is entirely independent from other rooms, and any motor is always ready for service as long as the machinery from which it derives its electricity is in operation.

The PRESIDENT. If there is nothing further to be said on this subject, we will pass to the next topic, "Metallic rolls; have they come to stay?" by Mr. H. L. PRATT of Lewiston, Me.

METALLIC DRAWING ROLLS.

By Mr. H. L. Pratt, Lewiston, Me.

There probably has been no one thing in the economy of cotton manufacture more ardently desired than an efficient substitute for the leather-covered drawing roll.

This roll remains in practically the same state as when invented by Arkwright in 1767, and, aside from the shell roll, is perhaps the only thing about the mill which has not been improved upon. The attempts to improve it have been many, so many, in fact, as to lead a large number of mill men to declare the roll incapable of improvement. This belief I myself shared to a certain extent until visited in August, 1891, by a representative of the Metallic Drawing Roll Company of Indian Orchard, Mass., who proposed to fit up and put in operation as many rolls as I desired, for a four months' trial. Feeling quite confident that the rolls had some merit, because several years ago I had experimented with fluted rolls, but had omitted an essential part, the collars, which I now at once saw would be of great advantage, I gave an order for five sets of railway rolls and twelve deliveries of drawing. The railway heads and drawing frames into which these rolls were put comprised one section of one of our card rooms, consequently there was no difficulty in keeping their product separate.

As soon as the new rolls were started we immediately noticed an improvement at the railway head, the tendency to

lap up having almost entirely disappeared. There was a great increase in the amount of dirt and leaf removed from the sliver.

The railway heads were the Biddeford pattern, five rolls. The weight attached to the rolls was reduced one-third, speed of front railway roll being 529 revolutions; diameter, 1⅜ inches; weight of sliver, 69 grains per yard; draft, 5.12.

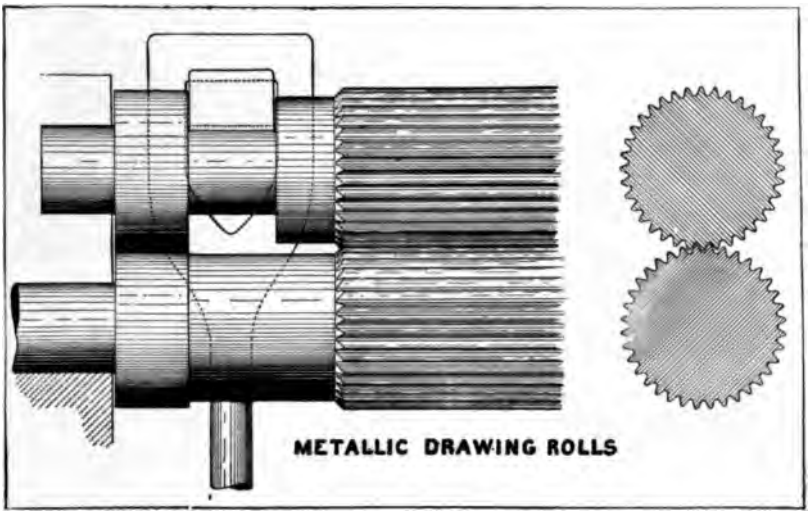
The drawing frame was made by the Whitin Machine Works, their late pattern, but without coilers, four-roll frame, and double four into one; draft, 4.87; speed of front roll, 318 revolutions; weight of sliver, 55 grains per yard.

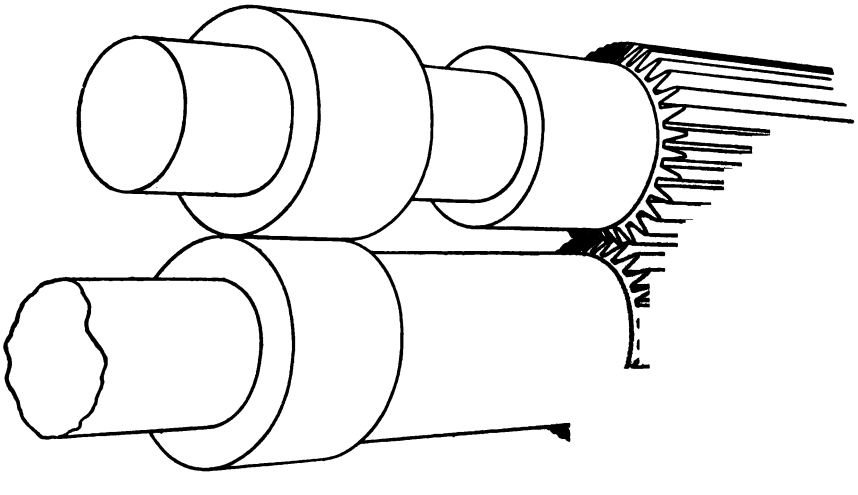
Here at the drawing frame the weights attached to rolls were also reduced one-third, the amount of dirt and leaf extracted from the sliver was very noticeable, there was less lapping up of the rolls, and the product was increased about 25 per cent.

The drawing thus made from these metallic rolls was passed through the subsequent processes of slubber, intermediate and fly frames in the ordinary way. The roving was marked differently, so as to distinguish it from the regular work. This roving was put into a certain number of spinning frames and carefully watched during a period of three months, and sizings and breaking strength of the yarn noted each day. The average number of the yarn was 26.97, and the average breaking strength was 73.47 pounds. The yarn tested from the metallic rolls showed it to be 13 per cent. evener, and the breaking strength 4½ per cent. stronger, than that from the leather-covered rolls.

The System Described.

A brief description of the rolls will furnish to those not familiar with them a clue to the reasons why they do better work than the ordinary rolls. Referring to the drawings here shown, it will at once be noticed that the rolls are practically gears. They are provided with collars shown at A, A,


METALLIC DRAWING ROLLS



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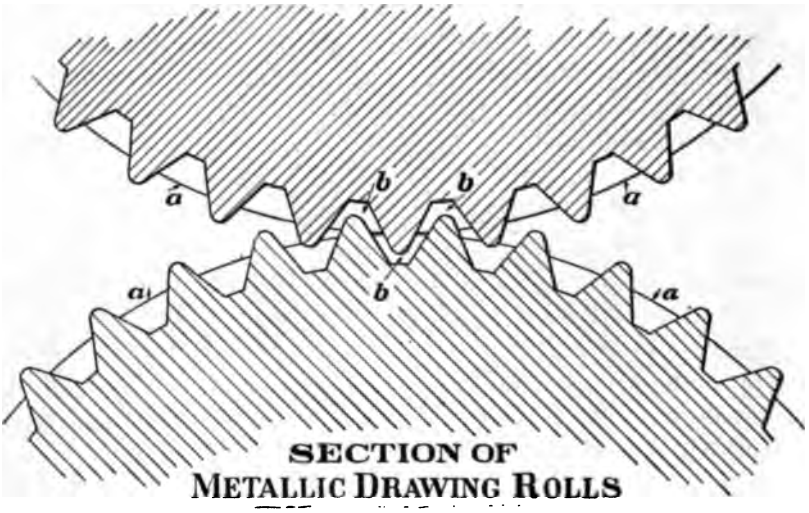
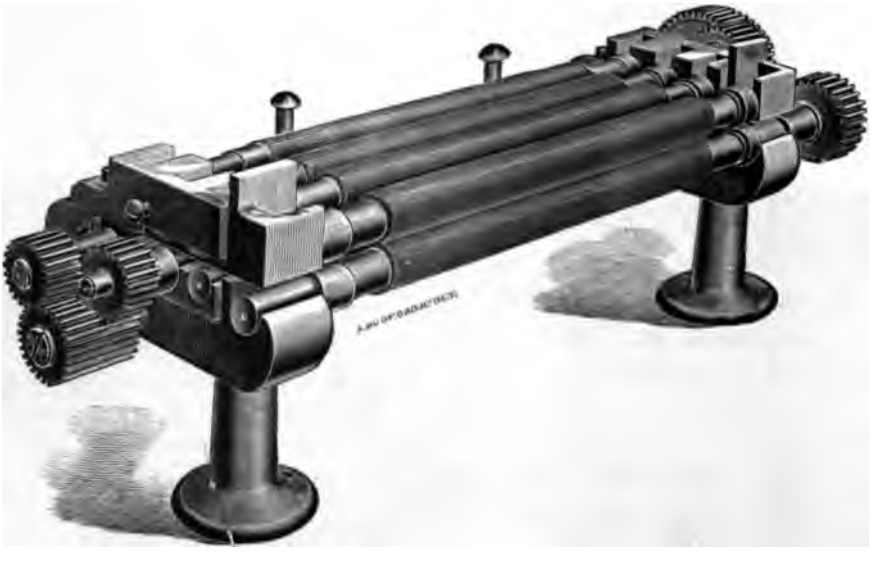


SECTION OF
METALLIC DRAWING ROLLS



which are identical in action with the shrouding sometimes used on heavy gearing to strengthen the teeth, being made to the exact pitch diameter of the gears. These collars touch and move in pure rolling contact, thereby preventing the points of the teeth from coming in contact with the bottom of the flutes or grooves, as they only intersect each other .044 of an inch.

This affords sufficient space for the sliver, and thereby prevents the crushing and cutting of the fibre which has proved fatal to all other attempts to run interlocking rolls in the past. The space referred to for the sliver is clearly shown in the drawing at B, B. This space is amply sufficient to permit the cotton to be compressed within the limit of its elastic capability, which gives the drawing the effect of a cushioned roll without any of its disadvantages.

Wear of Collars.

The question of the wear of collars at once arises. By referring to the drawing, we notice that the collars A, A, move, as before mentioned, in a pure rolling contact, that is, without slipping; hence the wear, if there be any, is reduced to a minimum, and would probably no more than keep pace with the inappreciable wear of the top of the flutes caused by the friction of the sliver being drawn. In fact, I think there is no doubt that the collars will last during the ordinary life of a frame.

Bite or Nip of the Rolls.

Bearing in mind that the metallic rolls are practically gears, adjusted by means of the collars, with sufficient "[illegible]ance" for the sliver, a moment's reflection will show th[illegible] or nip is at a point of contact of the interlocking [illegible]ng distributed through the number of flutes sim[illegible]-gaged. Hence there is a positive hold [illegible] fibre during the entire passage through [illegible] even and uniform attenuation.

Such a nip can only be obtained, if indeed it can be obtained at all in the case of common leather-covered rolls, by the use of very heavy weights, and, as a matter of course, these weights are destructive to the leather covering. With rolls badly covered or in bad condition, good drawing is impossible. Rolls are run till discovered to be doing bad work, and oftentimes turn out considerable such work before it is detected. Leather-covered rolls are certainly deteriorating from the time they are started until they are positively bad and are replaced. Roll covering being expensive, all intend to get as much wear from the rolls as possible.

The Draft.

In the metallic roll system the top roll is driven by the action of the flutes of the bottom roll. Here is a positive draft from direct gearing, instead of the slipping draft of the leather-covered top roll. This positive draft of the metallic roll entirely prevents the injurious action always present in the ordinary rolls, where the top roll is driven solely by the frictional contact of the bottom roll, which friction has to be transmitted through the medium of the sliver itself. It follows, therefore, that that part of the sliver in immediate contact with the bottom roll is extended *more* than that in contact with the top roll. There can be no doubt that this action, together with the slipping frictional bite which exists under the best and most perfect conditions of leather-covered rolls, is very largely the cause of imperfect drawing. The heavier the sliver, the more apparent this action and injury is.

It is a well-known fact that the draft by weight in the case of common leather-covered rolls is less than the figured draft. With the metallic roll the *reverse* is the case. I consider the reason for this due to two causes. One is the absence of all slipping between the rolls, and the other is the fact that the act of forcing the sliver into the flutes of the rolls introduces a slight draft. In order to obtain a draft of 4½ only a figured draft of about 4 should be made.

Electricity, Licking up.

There being no friction of leather on the sliver and no heating of rolls because of slipping and also because of excessive weighting, that great enemy of all carding, electricity, does not appear.

The leather covering being abolished by the metallic system, the bad effects of warm, damp, sticky weather on the varnish and leather of the old roll system are entirely obliterated.

Increased Product and Improved Quality.

The sliver, following the convolutions of the rolls, causes them to deliver about one-quarter more than the common roll of the same diameter. Therefore, to get the same production we may run the drawing rolls of a frame four-fifths of the speed required by the ordinary leather-covered rolls. This, with the reduction of weights, effects a noticeable reduction of power required to drive a frame, while obtaining the same production, but much superior in quality.

Inversely, running metallic rolls at the same speed as the common rolls of same diameter will give a production one-quarter greater than with the common rolls, and of better quality. This can be, and in fact is, taken advantage of by those to whom a saving of floor space is desirable. This increase of production is effected without increase of power, or, in case of a new plant, with little or no increase of first cost, the extra expense of the metallic rolls being cor
for by the reduced number of deliveries require
course refers to drawing alone.

The Crimp.

The crimp put into the sliver by the for
which at first appears to many as an alar
to be a *distinct advantage*, as demonstra
back at the next process. This is accor

that in the manipulation of the fibre by the rolls in all drawing processes there is a tendency of the fibre to curl and separate from the arrangement it has been the object of the process to accomplish. With the metallic rolls it must be obvious that the crimp in the sliver does so condense and unite the fibres that in its delivery to the calender roll it can suffer no disarrangement, and therefore the fibres are more firmly held together.

To summarize my experience, will say: —

First. — The metallic rolls are perfectly made, being ground down to extreme accuracy in size, and hence we start with and maintain at all times a perfect roll, working without friction on collars, which will, I believe, last almost indefinitely.

Second. — The bite of the roll is positive, and the draft direct and positive, thus requiring less weight and less power.

Third. — The rolls running on collars without friction admit of sufficient space to allow perfect attenuation of the sliver without injury, and possessing all the advantages of a cushioned roll.

Fourth. — The licking up from electricity and sticky weather is entirely overcome.

Fifth. — The imperfect or "cut work," arising from imperfectly covered or imperfectly varnished rolls or dry rolls because of lack of oil, is entirely eliminated.

Sixth. — The cost of roll covering, roll varnishing, delays because of sliver breaking down, licking up, and consequent waste, are saved.

Seventh. — The product is increased and quality improved.

Eighth. — Considerable more leaf and dirt are extracted from the sliver.

Ninth. — To sum it all, the quality of the product is much superior, producing yarn of much greater evenness and strength; therefore the metallic roll, in my opinion, has come to stay, and in fact I believe that ultimately it will be applied to speeders and possibly to spinning frames.

I desire to add just a word: if I ever have had any scales on my eyes regarding the possibilities of the metallic roll, they were removed yesterday on visiting the mills of the Merrick Thread Company at Holyoke. They have in their carding department an entire system of metallic rolls, and I have never been in any card room where the work was running so perfectly as there. I spent considerable time there, and I can say to you that I didn't see a girl piecing up an end, a very *unusual* occurrence. Some people may think that the clearance represented at B is not sufficient for the weight of the slivers; but I saw them passing under the rolls, with that clearance, a sliver that weighed 840 grains to the yard, spread on a twelve-inch boss roll, and you know how perfectly all their thread is made. The weight on the rolls all the way through is very much reduced, from 90 pounds to 5 pounds, I think, in some instances, and when they come to the fly and jack frames no weight is attached to the metallic roll. In new frames the metallic rolls were made in sections of four bosses, and their own weight was sufficient. I saw them making nineteen-hank roving made by the metallic roll throughout, and I hold in my hand a sample of a twenty-four-hank roving made in that way, and if you will examine it I think you will agree with me that I am not very far off in my prediction that we shall yet spin yarn with metallic rolls.

The PRESIDENT. You have listened to a very interesting paper, and you will now have an opportunity of discussing it or asking questions.

Mr. JOHN K. RUSSELL. Do you consider the metallic rolls as valuable when using a short staple as a long one; will the work be as good?

Mr. PRATT. As to carrying a short staple through the entire process with metallic rolls, I cannot from personal experience answer that question; but judging from what I saw I should say that there is no question that it can be done successfully.

Mr. RUSSELL. My experience with the metallic roll has been just the opposite. Where we have used a low grade of cotton, or a mixture of waste, in connection with the metallic roll, the result was such that we took the rolls out of this mill and put them in our other mill, where we are using a longer-staple cotton.

Mr. PRATT. In what stage of the process were your metallic rolls?

Mr. RUSSELL. In the drawing frame only.

Mr. PRATT. I think there is where we are laboring under a great mistake. In many mills where this roll has been put in the entire process has not been carried through. In many cases it has simply been applied to railway heads, which is no criterion for the test. I think if we apply it to the railway and drawings, and then make the test, we should then be able to determine whether the lack of success, should it occur, is owing to the metallic roll or to some other conditions.

Mr. RUSSELL. When I took the metallic roll out I put back the leather-covered roll, and my drawing was much better than when I had the metallic roll on. I have been very successful with the metallic roll on long-staple cotton.

Mr. F. M. MESSENGER. I would like to ask Mr. PRATT if in putting in metallic rolls he had to change the gears between front roll and calender roll.

Mr. PRATT. We changed the gear one tooth between front roll and calender roll. I think there are some other gentlemen here who have used these rolls.

Mr. J. J. CONNELL. I have run 164 deliveries with metallic rolls for a little over a year, from 1⅛ to 1½ inch staple cotton. I think from what the gentleman said who spoke of removing them that the trouble may have existed in the setting, or closing up of them. In using these metallic rolls, if they are not set exactly with the length of the staple, and allowance made for the weight of the sliver and the length of the staple, you get bad results; but if they are properly set the results are *splendid.* In my experience I can confirm everything that Mr. PRATT has said in regard to them.

Mr. RUSSELL. With regard to running the shorter staple of cotton, in the case I mentioned we run 25 per cent. of waste. We run some without the waste, that did better. In speaking about different rolls, perhaps we could not set rolls for every staple we used; we made all the trials we could by setting rolls in and out; but it was not found it would make any difference until we used a longer staple.

Mr. MOORE. I put in two railway heads and five deliveries drawing, using short-staple stock, kept them in four months, and made four tests a week; and carried that clear through to the spinning. The sliver was run through the same railway head and drawing, the same slubber and fly frame, and put on the same spinning frame; and after four months I had the rolls taken out. I have not the figures, but the yarn almost invariably broke at from three to seven pounds less than our regular yarn. In all this time there were one or two tests where the yarn with the metallic roll broke better, for some reason or other; but this was run through the same spinning frame, the same speeders and the same slubbers, and it was the same cotton exactly, and we laid it to its being short-staple cotton; there was no waste, and we concluded that the length of the staple made a great difference. We set the rolls in different ways, with the weights from none

at all up to the regular ones used with leather rolls; and I am sure we made as fair a test as possible. They didn't work with that length of staple, and we had them removed and our covered rolls put in in their place.

Mr. CONNELL. You have to adapt your roll to the length of your staple, or the results will be bad.

Mr. GEO. W. BEAN. In our fine mill we have the metallic roll in three railway heads and twenty-four deliveries of drawing. We also run for some little time waste stock through these rolls, and we had no difficulty whatever with the rolls, and the yarn tested from 5 to 7 per cent. stronger than with the common leather-covered rolls. We like the metallic rolls very much indeed.

Mr. R. R. SMITH. We have some metallic rolls in connection with one mill, where we spin waste and stained stock almost entirely. Sometimes bales of cotton come to us soiled or stained, perhaps the covering off, and this damaged cotton is thrown into a pile and with other waste is taken to the mill for making coarse yarns, Nos. 3 to 8. Since we have introduced the metallic roll drawing we have noticed a decided improvement in the yarn; it being stronger and the work running better. We have the metallic rolls in drawing frames in two other mills, and are so much pleased with them that we have given an order for an entire outfit of drawing frames in the other mills.

Mr. A. S. WINSLOW. All mills have trouble in running different lengths of stock, but different lengths have to be worked, especially in mills that run the cheaper grade of goods. I would like to ask Mr. PRATT's opinion as to the use of the metallic roll in connection with such stock.

Mr. PRATT. I don't comprehend the gentleman's inquiry. Does he refer to mixed stock, or stock of different lengths run separately?

Mr. WINSLOW. Yes, I mean mixed stock and stock of different lengths. If you have different lengths of staple

coming at the same time, how about using the metallic roll on such stock?

Mr. PRATT. If it is practicable to space the leather-covered rolls so as to adapt them to mixed stock, I see no reason why it is not practicable with metallic rolls.

Mr. HERVEY KENT. I have had a little experience with the metallic roll. I had one railway head running three years, and it worked remarkably well, and, in order to show that the right thing wants to be handled rightly, I may say that at the same time I knew of metallic rolls which were put into another mill sixteen miles from us, and they had a great deal of trouble there. Their carder was up to our place twice, to see if he could find out what the trouble was. Theirs did not work satisfactorily, but ours have worked so well that in the machinery I shall order for our new mill I intend to put the metallic roll into all our railroad heads and drawing, for I believe it is a very valuable addition. We use stock which we buy for 1⅛ inch staple, but a good deal of it is much shorter than that.

The PRESIDENT. We will take up the next paper, "The best method of heating a cotton mill," by Mr. CHARLES R. MAKEPEACE of Providence. Mr. PARKER has kindly consented to read this paper, Mr. MAKEPEACE not being present.

THE BEST METHOD OF HEATING A COTTON MILL.

By Mr. C. R. Makepeace.

In opening the discussion of the topic assigned me by the Board of Government, on "The best method of heating a cotton mill," I must say that conditions may be such that what is *best* for one may not be for another.

Thirteen years ago I was present, for the first time, at a meeting of this Association, at which time the subject of heating mills by steam pipes suspended from overhead was being discussed pro and con. Mr. Atkinson, I think, was calling the attention of the members to this style of heating, and advising its general adoption because of its effectiveness, cleanliness and safety, and, after speaking from strong convictions on the subject, he had no sooner finished than the late Geo. Draper remarked, "The system is good, but if many of the operatives have cocoa-nuts as smooth as mine they may object to hot steam pipes overhead." I quote Mr. Draper's remark simply because in it is the one thought I desire to call your attention to in opening the discussion of this subject.

The changing of the steam pipes from the side walls to overhead did not materially affect the conditions of the room or building, but did commend itself to all, as being far preferable to the old way, and, contrary to the expectations of many, did not increase the expense. I can conceive no better way of heating a building, if it is to be heated by direct radiation; but from some experience in the matter I must say, were I selecting a heating plant for a mill to-day, I would abandon

the overhead system and heat it by the method already adopted by many of you, and known as the blower or hot-air system; that is, blowing hot air into the room after the same has passed over a coil of steam pipe, which can be heated by live or exhaust steam.

The cost of this system is somewhat greater in its installation than any other used, and in most cases more expensive in its operation; but the fact that it heats the mill, and in a perfectly satisfactory manner, is not all that can be claimed for it. The atmospheric conditions secured by this system are much superior to the ordinary conditions existing in mills heated by steam pipes suspended overhead, and not only is the physical comfort of the operatives increased, but to this system or the advantages obtained can be traced an increase in production, both in quantity and quality. To fix any figure that would represent an exact value of the claim for the system in the direction of increased production is difficult to do, but sufficient evidence can be shown that will substantiate this statement. I have said nothing about the value of this system in the matter of ventilation, except what I have hinted at as to its advantages in producing better conditions in the room for the operatives, which is, of course, due to the fact that it is a ventilating as well as a heating system; but therein, I believe, lies one of its chief claims to your consideration. As you may know, it is used by our neighbors in the extreme Southern States as a strictly ventilating system during the summer months, being operated for carrying to the various parts of the mill fresh air, not heated, and possibly but little, if any, cooler than the air in the building, but, on account of its free and constant circulation, making a purer atmosphere and more easant conditions for the operatives. This I
the blower stopped during the
ally the case here in New
system, and no doubt for th
this climate. By referrin

mill in the South where the blower was not used for some time, and was started up on August 9, at 1.30 in the afternoon, and changed the temperature from 101° to 92°, a reduction of 9° F., in about twenty minutes. I only cite this one instance, as such data as I now have on this point is only sufficient to warrant the calling of your attention to this feature of the system.

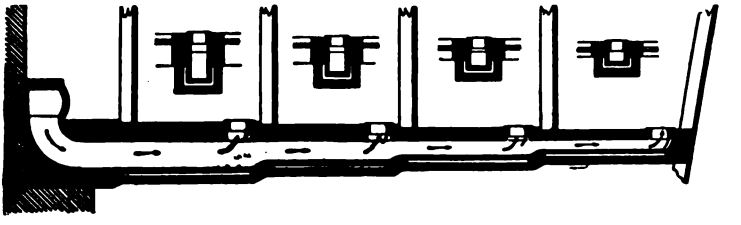
I believe that ice has been placed in the main duct where this system is used, and the air cooled by passing over it before entering the room; but this was found to be too expensive, as the ice rapidly melted, and gave but little better results in reducing the temperature of the mill than if water had been used.

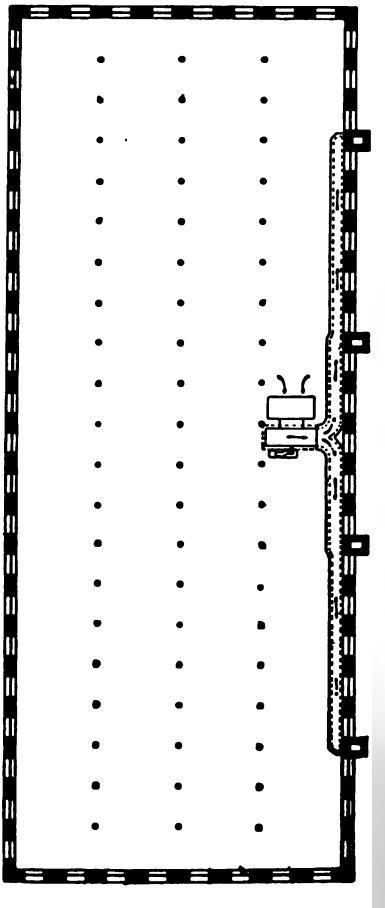
Various methods have been devised in connection with this system for moistening the air, as is required in some departments of a mill, before blowing it into the rooms, and failure in this direction has caused some to condemn the system. If a jet of steam or vapor is discharged into the main duct, any degree of humidity desired can be obtained; but all the air is moistened alike, and is distributed to the different rooms by the risers leading thereto, and that which is best adapted for one department in a cotton mill may not prove equally good for another; besides, the introduction of moisture at this point may work disastrously to the walls of the ducts and risers. In one mill this objection has been overcome at a trifling expense by carrying a steam pipe down through each room and putting opposite each opening in the flue, through which the air enters the room, an outlet with valves for regulating the flow of the steam; and then the exhaust steam from the engine which drives the blower flows into the room, and is caught up by the current of air passing from the flue, and is thus distributed throughout the room. This plan has worked so satisfactorily during this winter, that, as it is a necessity to have moisture during the summer months in some of the departments, they intend to try something on the same plan, using vapor or steam, or possibly both.

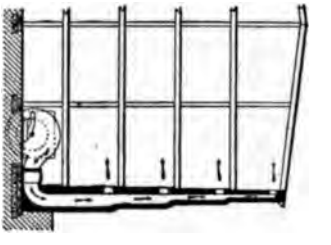
The following cuts help to show how this system is applied to a building, and of course the application is substantially the same, whether the building is one or more stories high. The blower or fan can be located at some convenient point, and the risers leading from the main ducts to the several rooms can be varied in number and location, to suit each particular case; in fact, they are sometimes put in each pier between the windows. In one case the usual projection of four inches for the pilasters was varied, every other one projecting eight inches, and the flues in the piers with an eight-inch pilaster led to the carding and spinning rooms, located on the third and fourth floors, and the flues in the four-inch pilaster connected with the weaving room on the first and second floors.

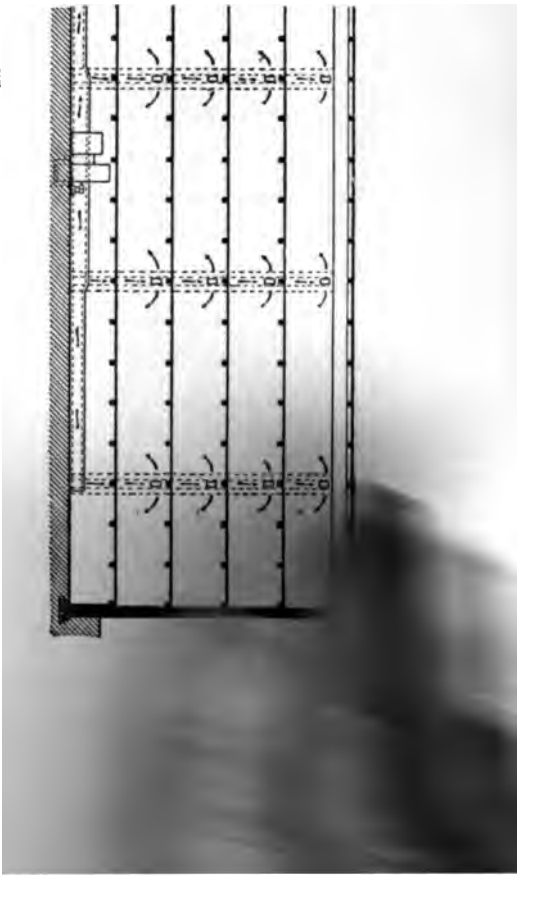
I have tried to get some reliable data regarding the cost of heating by overhead pipes, as compared with the hot-air system; but it is difficult to obtain, from the fact that the steam for heating purposes, in most cases, is taken from some common source of supply, and in such a way as to make it impossible to say what proportion is used for heating alone. However, in three cases where they heat by overhead steam pipes and have a small steam plant for no other purpose but to furnish steam for heating, the cost was, for one year, for fuel, nine and one-fourth cents per cubic feet of space heated, or, to express it in another way, about five cents per spindle; but the data I have been able to gather at this time bearing on the cost is such as will warrant me to use it in calling your attention to the matter only, and not to offer it as a standard. Only in one case have I been able to obtain reliable figures on the daily cost of the hot-air system, and they are per cent. higher than those obtained for the ov

To sum up, I believe the hot-air syst for heating a mill, and for the following r can be used as a ventilating system, is e produced are considered, is safer, more a room or building quicker, and you c that the same temperature can be hel









On motion of Mr. WEEKS, it was

Voted, that the Board of Government be authorized to lay an assessment on the members of the Association, not to exceed ten dollars each, to defray the expenses of the ensuing year.

The PRESIDENT. The material provided for this meeting has now become exhausted; therefore, any topic discussed at previous meetings is now in order, and if any member wishes to say a word on any subject he will now have an opportunity. I think Mr. GOODALE would like to make a few remarks.

Mr. A. M. GOODALE. I had supposed that my work on testing oil, so far as this Association was concerned, was finished at the October meeting, but certain things have arisen since that time, which I think may be of interest to you.

What I have given at the last two meetings was simply the tests of oils sold by the different dealers. Some of the oils tested were reported in both tests, and it was a chance remark by one of the dealers in regard to his own oil that led to further work on my part. The remark was this: "Our second oil shows very much better results than the first oil, but from an oil manufacturer's stand-point it was an inferior oil." Now, the kind of oil we want is an oil that will run the greatest number of spindles to the horse-power, not the best oil from the manufacturer's stand-point; and it occurred to me that possibly manufacturers or dealers were unable to furnish an oil that would run a large number of spindles, simply because it would not occur to them, from the inferiority of the product, judging from their stand-point, that it would do so.

I reasoned that the lighter and more fluid an oil was, the more spindles it would run in confined bolsters; and following out this line of reasoning, my first test was on plain, ordinary Charles River water, on the same frame that I had used for testing in April and October, and this water gave four more spindles to the horse-power than the best oil on either of the tables. There were some slight drawbacks, such as rusting,

but the line of reasoning that I was working on seemed to be sustained.

Now, the nearest approach to water in the oil line was kerosene; and my second test was on a high-grade kerosene, practically a 300 burning oil, from which the wax had been pressed, and with this oil I obtained in the same frame 114 spindles to the horse-power, or 20 spindles more than the best oil tested in October. The flash and fire test on this oil would have been high enough to satisfy the insurance companies, had the percentage of volatile matter in the oil been below 5 per cent. Unfortunately, it showed between 7 and 37 per cent. This rendered it an oil impossible to use. I had this oil returned to the makers from whom I bought it (Seccomb, Kehew & Sons), and asked them to pass warm air through it, at a temperature of 120°, in order to rid the oil of its volatile matter. This is now being done, but unfortunately I commenced this series of experiments too late in order to get the test on this oil, after the warm air had passed through it, ready for this meeting. Seccomb, Kehew & Co., however, furnished me with an oil very similar to this 300 burning oil, the only difference being that it was mixed with 10 per cent. of low-flash spindle oil. This oil I have had tested at the Institute of Technology for flash and per cent. of volatile matter, the flash being 280 and the percentage being 3.41. The percentage of volatile matter being under 5 per cent. and the flash point as near to 300 degrees as it is, this oil will be accepted by the insurance companies. With its use you are perfectly safe as regards danger from fire, and you can run under the same conditions at least 15 spindles to the horse-power more than you can with the best oil tested in the October table.

I have also commenced a series of tests on some high-gravity oils furnished by Borne, Scrymser Co. of New York, with almost equally good results. They enter very heartily into my plans for getting a light fluid oil with as little viscosity as possible.

Mr. WOODBURY. It seems to me that the problem of lubrication goes a little farther than the number of spindles that can be driven per horse-power. There are three elements in lubrication: the cost of wear and tear of machinery, the cost of power, and the cost of the lubricant. Now, it is possible, I believe, by using very thin oil, to impose a great deal larger amount of wear upon the frictional surfaces. I say that without allusion to any possible danger of heating, because I do not believe it necessarily exists, as, if water were used as a lubricant and a sufficient supply provided, there would be no danger of a hot bearing, but there would be very rapid wear of the machinery. In connection with the mixing of oils, I would remind those who propose to try to mix oils for themselves, that, if an animal oil is mixed with a mineral oil, there is a chance that the cohesion between the two will not be good, unless done at a temperature of 100°; because when oils are mixed at ordinary temperatures they will afterwards separate one from the other, the heavier one going to the bottom of the tank. I remember the case of a mill using, a few years ago, a mixture of ten per cent. of neat's foot oil to ninety per cent. paraffine, and it was found that the neat's foot oil had settled at the bottom, and they were using a mixture which contained over ninety per cent. of neat's foot oil. The mixture of two petroleum oils takes place much more readily than the mixture of animal and paraffine oils.

Mr. GOODALE. If the difference between the temperature of the rail of the spinning frame and the temperature of the room is very slight, does this not indicate that the use of a light fluid oil causes but little friction? Experiments made by me so far with this light fluid oil have shown less difference between the rail temperature and the room temperature than has been the case with any of the ordinary spindle oils heretofore tested.

Mr. WOODBURY. As a general proposition, the tempera-

ture of a bearing represents a measure of the power absorbed in friction, but it does not necessarily indicate the relative value of a lubricant. With a heavier oil that friction may be used in pulling the particles of the thick film of oil over each other and also along the metal surfaces of the journal, for which it has great adhesion; and, with a light oil, that heat may be caused by the friction of the metal surfaces of the bearing chafing against each other.

On the other hand, the film of water or of a thin lubricant may be so thin that the surfaces of the journal may come in sufficient contact to be worn away by the collision of projecting particles of metal; and, while the power required to do this may be less than in the former instance, yet the lubricant may not serve its full purpose in protecting the surfaces against wear.

Lard oil furnishes the best example of an oil having a strong adhesion to metals, even when heated, and it is this property which fits it for use on iron-cutting tools.

The warmth of bearing may be due to the wear of the metal against the metal, or of the agitation of a very thick oil among its own particles.

The PRESIDENT. The Secretary has an amendment to one of the articles of our constitution to present for your consideration.

The SECRETARY. At one of the meetings of the Board of Government this matter was discussed, and a change proposed in relation to the election of officers, and their tenure of office. The By-laws provide that any amendment must be proposed at one meeting and acted upon at the next; and I was requested to present this, at this time: —

It is proposed to amend ARTICLE II. to read as follows: —

ARTICLE II. There shall be a meeting of the members of the Association, annually, on the last Wednesday of April; or at such other time,

and at such hour and place, as the Board of Government may determine. At the first annual meeting after the adoption of this article there shall be chosen by ballot a President, two Vice-Presidents and six Directors. Two of the six Directors shall be chosen for a term of three years, two for a term of two years, and two for a term of one year; and thereafter, annually, two Directors shall be chosen by ballot for a term of three years. The President, or in his absence the senior Vice-President, shall preside at all meetings of the Association and of the Board of Government. The officers chosen at the first meeting shall hold their offices until the next annual meeting, and until others shall be chosen in their stead. There shall also be a semi-annual meeting of the Association on the last Wednesday of October, in each and every year, or at such other time, and at such place and hour, as the Board of Government may appoint. Special meetings may be called by the Board of Government whenever they may deem it expedient, or upon the written application of any ten members made to the Secretary, provided notice is given to the members, as in other meetings.

The PRESIDENT announced that dinner would be provided for the members of the Association, at the THORNDIKE, at the close of the meeting; and it was then —

Voted, to adjourn.

(No. 55.)

N. E. COTTON MANUFACTURERS' ASSOCIATION.

PROCEEDINGS

OF THE

SEMI-ANNUAL MEETING,

HELD AT BOSTON,

OCTOBER 25, 1893.

BOSTON:
WRIGHT & POTTER PRINTING CO.
18 POST OFFICE SQUARE.
1893.

[No. 55.]

N. E. COTTON MANUFACTURERS' ASSOCIATION.

PROCEEDINGS

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HELD AT BOSTON,

OCTOBER 25, 1893.

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CALL FOR MEETING.

BOSTON, Oct. 5, 1893.

DEAR SIR: —

The stated Semi-annual Meeting of the Association will be held at the MASSACHUSETTS INSTITUTE OF TECHNOLOGY, *Boylston Street*, *Boston*, on

WEDNESDAY, OCTOBER 25, 1893, at ten o'clock A. M.

The subjoined Amendment to the By-Laws, offered at the April meeting, will be in order for action.

It is proposed to amend ARTICLE II. to read as follows: —

ARTICLE II. There shall be a meeting of the members of the Association, annually, on the last Wednesday of April; or at such other time, and at such hour and place, as the Board of Government may determine. At the first annual meeting after the adoption of this article there shall be chosen by ballot a President, two Vice-Presidents, and six Directors. Two of the six Directors shall be chosen for a term of three years, two for a term of two years, and two for a term of one year; and thereafter, annually, two Directors shall be chosen by ballot for a term of three years. The President, or in his absence the senior Vice-President, shall preside at all meetings of the Association and of the Board of Government. The officers chosen at the first meeting shall hold their offices until the next annual meeting, and until others shall be chosen in their stead. There shall also be a semi-annual meeting of the Association on the last Wednesday of October, in each and every year, or at such other time, and at such place and hour, as the Board of Government may appoint. Special meetings may be called by the Board of Government whenever they may deem it expedient, or upon the written application of any ten members, made to the Secretary; provided notice is given to the members, as in other meetings.

After the conclusion of the business of the meeting, the Board of Government take pleasure in announcing the following topics for discussion, to be opened by the members named below.

1. The Unit of Power for Cotton Mills.

   Mr. F. M. Messenger, North Grosvenor Dale, Conn.

2. The Long Traverse and Large Ring, as applied to spinning.

   Mr. A. F. Knight, Manchester, N. H.

3. Methods of making up Costs.

The following members have consented to state their several methods: —

Messrs. H. F. Lippitt, Manville and Social Mfg. Cos.,
Franklin Nourse, York Mfg. Co.,
R. W. Eaton, Cabot Mfg. Co.,
John Holland, Cocheco Mfg. Co.,
E. W. Thomas, Tremont and Suffolk Mills,
W. J. Kent, Wamsutta Mills.

4. The Cost of Steam per Horse-power, per Year, where mills are using plain condensing engines.

A report from a committee of the Board will be presented, giving facts upon the subject.

5. Mill Construction.

   Mr. Edward Atkinson, Boston, Mass.

At the close of the morning session the Association will dine together. This dinner, as heretofore, will be paid for from the treasury, and be free to all members.

By vote of the Board of Government,

AMBROSE EASTMAN,
Secretary.

PROCEEDINGS.

Pursuant to the foregoing notice, the stated semi-annual meeting of the Association was held at the Massachusetts Institute of Technology, Boylston Street, Boston, on Wednesday, Oct. 25, 1893, at 10 o'clock A. M.

The President, Mr. ROBERT MCARTHUR, occupied the chair.

The Secretary read the call for the meeting.

The PRESIDENT. Gentlemen, you have heard the call for this meeting, and I presume that the first business will be to act upon the amendment to the By-Laws.

The proposed amendment was thereupon read by the Secretary.

Mr. WALTER E. PARKER. Mr. Chairman, I move the adoption of the amendment proposed.

The motion was seconded.

A MEMBER. I notice the proposed amendment provides for the presiding of the senior vice-president, and not for the presiding of the other vice-presidents. It says in the absence of the president "the senior vice-president shall preside."

The PRESIDENT. I suppose the junior vice-president would preside in case neither the president nor the senior vice-president was present; or it would be at the pleasure of the meeting to call some one to occupy the chair.

Mr. WOODBURY. It seems to me reasonable to suppose that the clause refers to the senior vice-president among those vice-presidents present.

The motion to adopt the amendment to Article II. was then unanimously carried. The Article as amended reads as follows: —

ARTICLE 2. There shall be a meeting of the members of the Association, annually, on the last Wednesday of April; or at such other time, and at such hour and place, as the Board of Government may determine. At the first annual meeting after the adoption of this article, there shall be chosen by ballot a President, two Vice-Presidents and six Directors. Two of the six Directors shall be chosen for a term of three years, two for a term of two years, and two for a term of one year; and thereafter, annually, two Directors shall be chosen by ballot for a term of three years. The President, or in his absence, the senior Vice-President, shall preside at all meetings of the Association and of the Board of Government. The officers chosen at the first meeting shall hold their offices until the next annual meeting, and until others shall be chosen in their stead. There shall also be a semi-annual meeting of the Association on the last Wednesday of October, in each and every year, or at such other time, and at such place and hour, as the Board of Government may appoint. Special meetings may be called by the Board of Government whenever they may deem it expedient; or upon the written application of any ten members made to the Secretary; provided notice is given to the members, as in other meetings.

The President submitted the following nominations of new members, recommended by the Board of Government, for election: —

HENRY A. BAILEY	Chicopee Falls, Mass.
GEORGE W. BELT	Lewiston, Maine.
WM. WASHINGTON BLADES . .	Westerly, R. I.
WILLIAM R. HILL	So. Hadley Falls, Mass.
WILLIAM P. HOLT	Slatersville, R. I.
WILLIAM G. NICHOLS . . .	Lowell, Mass.
S. ODENHEIMER	New Orleans, La.
ABBOTT E. SLADE	Fall River, Mass.
W. H. SUMMERSBY	White Rock, R. I.

On motion of Mr. HERVEY KENT, the secretary was authorized to cast one ballot for the persons named, and they were elected members of the Association.

The PRESIDENT. We will now proceed to the reading of papers upon the topics in order. First, "The Unit of Power for Cotton Mills," by Mr. F. M. MESSENGER, of North Grosvenor Dale, Conn. Mr. MESSENGER is not present. He is now in Chicago. Quite a number of members to whom topics were assigned are away in Chicago, or have just returned; and cannot attend. If I had consulted my own inclination or interest, I should not have been here, myself, to-day. Therefore, I cannot censure others who are absent. In regard to this topic, Mr. PARKER has kindly consented to read Mr. MESSENGER'S paper. As Mr. MESSENGER is absent, of course we cannot ask pointed questions; still, his paper may be discussed after the reading.

Mr. WALTER E. PARKER then read Mr. MESSENGER'S paper, as follows: —

HOW MAY WE ESTABLISH A STANDARD OR UNIT OF POWER FOR COTTON MILLS?

By Mr. F. M. Messenger, of North Grosvenor Dale, Conn.

Power is an item that enters into the cost of manufacturing so largely that mill owners expend large sums in improvements to lessen the cost of its production. Cost per horse-power has become as familiar a phrase as "cost per pound." The manager who adopts the most approved and economical methods in his power department is considered "up to the times," but while a special point is made of the *cost* of horse-power, not so many are clear as to the amount of power being used, and many are less clear regarding the number of horse-power that *ought* to be used under certain conditions.

A man having a tapeworm was daily growing more emaciated; he had a voracious appetite, still he reasoned that he should eat more; but his expenses were exceeding his means, so he concluded that expenses must be lessened; he bantered the butcher and jockeyed with the baker until he succeeded in reducing prices to their lowest point; still his expenses were too high; he set his inventive genius at work improving the methods and thereby cheapening the cost of producing the necessities of life, but demands increased faster than prices lessened; he finally thought something must be wrong with himself, consulted a physician, and was cured. Have not many of us seen, somewhere in our experience, a cotton mill having a tapeworm in its power department? The manager didn't know it, he wouldn't believe had he been told he was feeding it at a minimum of cost per unit, but the units were enormously large.

We expect to make a reduction in the cost per horse-power at one of the mills of the Grosvenor Dale Company, by adopting improved methods; the plant is about 1,150 horse-power,

making it quite an important factor in reducing the cost of production; but how about the power consumed in operating this mill? Is it excessive? That is equally important to know but not so easily solved; if power costs too much per unit we should reduce that cost if it can be done at a warrantable outlay; if the units used are excessive it is equally our duty to cut that down, but in order to search out the difficulty and apply the remedy we must realize the need of doing so. "They that are whole need not a physician." "How (then) may we establish a standard or unit of power for Cotton Mills?"

If A and B should operate separate plants identical in makeup, and both producing the same class of goods, it would be an easy matter to establish a standard between them, although A might run his machinery at a higher rate of speed than B, and thereby consume more power; it would be practicable to demonstrate whether A had passed the economical limit, or B had fallen below it; but when we consider the combination of conditions under which it becomes *necessary* to operate different mills, the various models of machinery, the wide range of counts of yarns, and the multitude of styles and construction of goods, it would require more than a Philadelphia lawyer to theoretically figure out a standard; of course there is a kaleidoscopic variety of notions entertained by different men regarding the *details* of manufacturing, such as care of belts, lubrication, weighting rolls, etc., etc., which affect power; but these differences should not exist, they are unnecessary; intelligent standards are the altars upon which false notions are sacrificed and with a "standard or unit of power" established, these hobbies would be hunted out, the crank called down, and faults corrected.

In the mills under the writer's charge, readings are ta[illegible] from wheel gates and indicator cards taken fro[illegible] gines t[illegible] daily, and by tables and computations the to[illegible] power d[illegible] oped is worked out and report of same rend[illegible] to the [illegible] each day. In this way we have on record v[illegible] inform[illegible] and while we doubtless have faulty pr[illegible] that c[illegible]

power uselessly, it is not an easy matter to introduce a new one, to put on another brake without being detected. We have three separate power plants; Nos. 1 and 2 mill (reckoned as one plant) require about 1,150 horse-power; mills are run on a variety of plain and fancy goods, average number of yarns about 40s; preparation consists of American system of double carding, about eighty per cent three, and twenty per cent four, processes of roving; warp yarns spun on frames and filling yarns spun on mules. No. 3 mill requires about 250 horse-power, making plain sheetings 80 x 92, 40 inches wide, average number of yarns, 32s; we have here American system double carding, three processes roving, warp and filling *all* spun on frames. No. 4 mill requires about 350 horse-power, all on plain goods, same as No. 3 mill. Average yarns, same; carding system, same; but filling yarns are spun on mules; warp yarns on frames. The weights per horse-power produced at these mills, stand relatively (calling one the unit), as follows; No. 2 mill, ninety-two per cent; No. 3 mill, eighty-six per cent; and No. 4 mill one hundred and two per cent. Looking at it, then, from the coal pile it would seem as though frames for spinning filling are not economical. It is our opinion, however, that it can pay its way in other advantages that it has over mules.

Tabulating results, we have the following: —

Mill.	Horse-power Required.	Style of Goods.	Average Numbers of Yarns.	Carding Preparation.	Processes of Roving.	Spinning Processes.	Relatively per H. P.	
							Weight.	Spindles.
No. 1. No. 2.	1150	Plain and Fancy.	40s	American System. Double.	80%. 3 Processes. 20%. 4 Processes.	Mules and Frames.	92%	57
No. 3.	250	Plain. 80 x 92	32s		3 Processes.	All Frames.	86%	38
No. 4.	350	Plain. 80 x 92	32s		3 Processes.	Mules and Frames.	102%	49

I will say that No. 3 mill is older, and equipped with less modern machinery than Nos. 2 and 4 mills, but the speeds are universally lower, and it is our opinion that the difference in power fairly represents the difference in equipment.

Now we have not attempted to answer definitely how this unit of power may be established. We feel certain that it cannot be worked out theoretically, but we believe it to be an important matter, one that this Association is deeply interested in, and we recommend that a committee be appointed by the Association to gather data and information from a sufficient number of representative mills, showing what is actually being done under different conditions. This information might be obtained by some disinterested party (the Secretary, for instance), and submitted to the committee, denoting the different corporations by letters. From such a collection of data, carefully and correctly obtained, it is our opinion an intelligent "standard or unit of power for cotton mills," may be established.

The President. Gentlemen, you have heard the paper of Mr. Messenger read by Mr. Parker, and you now have an opportunity of discussing it. Does any member wish to say a word on this subject? If not, we will take up the next topic in order, "The Long Traverse and Large Ring, as applied to Spinning," by Mr. A. F. Knight, of Manchester, N. H.

LONG TRAVERSE AND LARGE RING AS APPLIED TO SPINNING.

By Mr. A. F. Knight, Manchester, N. H.

In considering this subject we will take for a standard No. 28 yarn.

During the last decade, at least, it has been common practice to spin No. 28 yarn on a spinning frame having 2½ inch gauge, 5 to 5½ inch traverse, and 1⅝ inch ring.

It is assumed, therefore, that longer than 5½ inch would be considered long traverse, and greater diameter than 1⅝ inches a large ring.

We will, therefore, take a 6 inch traverse and 1¾ inch ring as being long enough and large enough to be considered long traverse and large ring.

The features most likely to be interesting to this Association are the advantages and disadvantages.

The advantages we believe to be less doffing and spooling, consequently less knots and better weaving. The disadvantages are increased power and harder spinning.

The latter can be largely overcome by using a wide separator. The increased power is more than offset by decreased cost in the spinning department, leaving the gain in weaving a clear one, with nothing to offset it.

Let us make a comparison from some tests made by an able New England manufacturer. His report shows 72^{7} spindles per horse-power, with 5½ x 1⅝ inches bobbin, and 68^{2} spindles per horse-power, with 6 x 1¾ inches. The spindles and front roll running the same speed in each case.

If we take a room containing 13,500 spindles, the power in one case would be 185^{6} horse-power, and in the other 198

horse-power, a difference of 12^4 horse-power, which at $35 per horse-power, per year, would amount to $434.

The difference in spooling alone should be as follows: —

6″ x 1¾″ Doff once in 6 hours, 39 minutes = 399 minutes.

5½″ x 1⅝″ Doff once in 4 hours, 53 minutes = 293 minutes.

A difference of over 36 per cent.

It costs in the average mill about 45 cents for 100 pounds to spool; 36 per cent of 45 cents would be 16^2 cents per 100 pounds saved.

The product of 13,500 spindles for one year at 1^4 pounds per spindle per week for fifty weeks would be 945,000 pounds; a saving of 16^2 cents per 100 pounds would amount, therefore, to $1,530.90. This shows a saving in spooling alone of nearly $1,100 a year, after deducting the cost for extra power. The cost for doffing in the average mill has been about 1¾ mills per pound, which would amount to $595.35 on a year's product of the 13,500 spindles. Thus you will see that we have saved $1,702.25 after paying for the extra power amounting to $434.

Nor is this all. For who can estimate the saving in the weaving department?

Let us follow the yarn through the mill from the spinning frame and see if we can form any idea of the gain made by saving knots.

In the average mill as run to-day, there are two thousand yards of No. 28 yarn put upon a bobbin on the spinning frame. The length of yarn on a bobbin varies but little.

When the yarn is wound from the bobbin on to the spool, another thread is spliced by tying a knot, and this operation is continued until eight or ten bobbins have been wound on the spool. Then the spools are placed in the warper creel an[illegible]he yarn is wound off on to the beam, generally holding 1[illegible] to 18,000 yards. Now we will say each thread has ni[illegible], these knots are 2,000 yards apart. Suppose the c[illegible]e fifty yards long in the yarn and twenty cuts put o[illegible], then every second warp in the looms has a [illegible]

By experiment, it is found these knots e[illegible]

or four cuts. We have a paper here that was filled out by a weaver with marks representing the breakage that occurred while weaving the three or four cuts, while the knots were coming up.

Imagine a weaver running six looms with three such warps. As a matter of fact, it is seldom such places come up on two looms run by the same weaver at the same time; but as we have shown you, they are only forty cuts or two thousand yards apart in the average mill. What wonder is it that weavers complain of knots?

With the 6 x 1¾ inches bobbin, the same conditions exist with the exception that the knots are three thousand yards apart, consequently there is a saving of one third of the knots. Instead of having a set of knots in every second warp in the looms, it would be in every third warp.

To sum up the advantages then of a long traverse and large ring over the ordinary practice: —

There is a saving in the spinning department which is nearly equal to five times the cost of the extra power consumed.

A reduced cost in weave room, which perhaps cannot be estimated.

Better quality of goods and less labor in both places.

I will add: We have running in our mills several thousand spindles with seven-inch traverse and two-inch ring. The bobbins hold over 6,000 yards of yarn, and the frames run ten hours between doffs. A girl spools for 2,400 spindles and helps doff the frames.

We put this yarn into the hardest goods we have to weave, and have never heard a complaint from the weavers since.

The President. Gentlemen, you have heard the paper read by Mr. Knight, and you now have an opportunity of entering into a discussion of the subject.

Mr. Eccles. I would like to ask Mr. Knight what would be the gain in the spinning, if the spinning would run equally

as well with a long traverse; and does he apply those to coarse numbers or fine numbers?

Mr. KNIGHT. I took as a standard No. 28 yarn. I think I gave a tolerably good idea of the gain when I showed that in a plant of 13,500 spindles there would be a gain of something over $1,700 just in the spinning alone, after paying for the extra power.

The PRESIDENT. Is there any other gentleman who would like to ask Mr. KNIGHT a question? He is abundantly able to answer.

Mr. HERVEY KENT. I would like to ask Mr. KNIGHT if he has numbered the yarn on the empty barrel and on the outside, and if he finds any difference in the number; or if he has any eveners whereby he overcomes that difference?

Mr. KNIGHT. I have had that question asked me before, and I know that theoretically there would seem to be a difference in the number of the yarn, but as a matter of fact, I do not find any. And if you gentlemen, who have the theory that the yarn is finer on the empty bobbin, that it does not break as strong, or something like that, will take a certain number of bobbins and reel them off from beginning to end, I am convinced you will find the same results that I have; that is, that there is not any difference between the empty and full bobbin. The theory is that there will be less twist, because it takes more turns of the spindle to wind the product of the front roll on the bobbin; but, as a matter of fact, I find no difference, and I have talked with several gentlemen who have tried the same experiment, and I find that they do not discover any difference. Mr. PARKER, I think, has tried the same thing.

Mr. KENT. I understand you have not any eveners?

Mr. KNIGHT. No, sir; I have not.

Mr. KENT. Your theory knocks Mr. DRAPER'S pa
evener in the head, does it not? I know a place wher
are putting on eveners to overcome that difference.
think they are making a great gain by so doing.

Mr. KNIGHT. I think I know the place you refer to. But, as a matter of fact, I do not find any difference. Do you, Mr. PARKER?

Mr. PARKER. I never have.

Mr. KNIGHT. If you try the experiment of sizing the yarn from a full bobbin to an empty one, I think you will be convinced there is no difference. It comes one way as often as the other.

Mr. KENT. The reason that I spoke of it was, because you have gone to an extreme; and that ought to test the principle, if it is correct. The theory that we have always held, is, that the yarn was finer on the empty barrel.

Mr. KNIGHT. Mr. BOURNE has made that experiment.

Mr. DRAPER. I think there is one great difference in the filling frame and in the warp frame. In the filling frame the barrel of your bobbin is only about three eighths of an inch in diameter, while on your warp frame it is from three fourths of an inch to an inch; and that would be a very vital difference, affecting the whole result, as between the filling and the warp, while the theory might be the same.

Mr. KNIGHT. There is less twist in filling than in warp.

Mr. KENT. It seems to me the ratio would be larger on the warp than it would be on the filling; between the empty and the full bobbin.

Mr. DRAPER. Yes; but if you take an empty spindle without any bobbin, you cannot spin filling, because the draught will break the yarn. So you have to have a bobbin to spin the filling at all.

Mr. STEPHEN GREENE. I would like to ask what his experience is concerning spinning filling as to the longer traverse and larger ring, in regard to getting less changing of shuttles in the weaving?

Mr. KNIGHT. I have not spun very much filling on the spinning frame for a good many years, gentlemen; but I will tell you of a little experience we have had in our mill. We had some old spinning frames that we intended to throw out

of the mill, but finally concluded we would keep them and spin filling on them. The frames were arranged with an inch and three-quarters ring. The spindles were two and one half inches apart. I think the traverse is something like five and one half or six inches. The overseer of the spinning room started those frames with an inch and three-quarters ring, and a bobbin rather larger than the average filling bobbin. I had an idea they would not run well with the inch and three-quarters ring on filling: and I suggested some smaller rings; and I bought some smaller rings for one frame, and he said the frame ran better; and I then bought enough rings for all of these frames. But in the meantime we got short of warp, and turned these frames over; and they ran on warp yarn for quite a little while. Finally we changed them to filling again, and put the new inch and three-eighths rings in. And they had been running but a short time when I had a complaint from the weave room that the yarn pulled off the bobbin; that it was not wound hard enough on the bobbin. I told the spinner to put on a heavier traveller, and had him change his traveller several times until he got a traveller that wound the bobbin hard enough so there was no complaint from the weave room. Then he came to me and said, "Now you have fixed me so I am worse off than I was before." And I have been trying some experiments, and I find, if it is necessary to wind the bobbin as hard as I am winding it now in order that it should weave, I can do it better with an inch and three quarters ring, with a light traveller, than with an inch and three eighths with a heavy traveller. But you must take into consideration the circumstances. The inch and three eighths rings were new ones, and the inch and three quarters rings were old ones, had been run a long time, and, of course, were smooth. That is, perhaps, a singular experience, but as near as I can get at it, those are the facts of the case, and the filling did spin better with the old ring and the light traveller than it did with the new ring and heavy traveller.

Mr. W. J. Kent. I understand Mr. Bourne has had con-

siderable experience with this seven-inch ring and two-inch traverse, and I would like to call on him.

Mr. S. N. BOURNE. I do not know that I have much to add to what Mr. KNIGHT has said. If anybody looks at it as a matter of economy, that is all there is to it. With the competition we have now, we must cut corners where we can; and I think we can spin cheaper with a two-inch ring and seven-inch traverse. I have quite a number of them running, and see no reason for changing.

Mr. DRAPER. I would like to ask Mr. KNIGHT how much slower he thinks it necessary to run spindles on No. 28 yarn, using a seven-inch traverse and two-inch ring, than to run spindles with a five and a half inch traverse and an inch and five eighths ring, to get the same result. I mean in spinning; so that one girl will tend the same number of spindles in each case, and keep the ends up as well in one case as in the other.

Mr. KNIGHT. I wish to say that I did not present the seven-inch traverse and two-inch ring. I know that my fellow-members on the Board of Government expected that I would. But I did not want to come before this august assembly and tell you about something that I did not know anything about. And I think I do know, and I feel perfectly safe in saying, that the six-inch traverse and inch and three quarters ring are perfectly safe things for a man to run on No. 28 yarn. I believe also that the seven-inch traverse and two-inch ring are all right. But if I was going to say to-day what I believe to be the most economical thing, all things considered, for a manufacturer to do, I would say this, that for No. 28 yarn he had better put in a six-inch traverse and two-inch ring. Now, Mr. Draper asked me how much slower it is necessary to run a seven-inch traverse than a five and one half inch traverse. I will say we are now running the six-inch (mind you, that is what I was talking about in the report, the six-inch traverse and inch and three quarters ring) at about the same speed run in first-class mills; that is to say, 9100 revolutions of the

spindles, and 112 revolutions of the front roll. Our seven-inch traverse and two-inch ring we are running eight thousand. But if the spindle will carry the load, all right. (Mind you, I wish to be careful because I do not want any of you to say I got you into a scrape.) I am rather of the opinion that the time will come when we will run a seven-inch traverse and two-inch ring as fast as we are running the inch and five eighths ring and the five and one half inch traverse to-day. In other words, I have found no difficulty in spinning at eight thousand revolutions of the spindle and a little over one hundred revolutions of the front roll with the seven-inch traverse and two-inch ring. Our spinners say it is the best spinning that we have in the mill; and as a matter of fact we pay less money for running those spindles. I just figured it out a few moments ago, and I find it cost us thirty one hundredths of a cent to spin on the seven-inch traverse and thirty-five one hundredths of a cent to spin on the six-inch traverse. I have one boy who runs 1792 spindles with seven-inch traverse and two-inch ring. All the spindles in that mill are arranged that way. I think that Mr. Draper's separator will settle the speed.

Mr. Eccles. I would like to ask Mr. Knight if there is any difference in the yarn, if the yarn is as smooth with the seven-inch traverse. I should think it would be apt to make the thread rather rough.

Mr. Knight. I have found that thing, that if you run a light traveller it is very apt to leave fibres standing out on the yarn. I do not know what you refer to, exactly, by smoothness; whether you mean unevenness in the yarn itself?

Mr. Eccles. I mean just smoothness in the yarn, from the fibres.

Mr. Knight. Well, the only way I have of judgi we keep a record every day of the number of ends down in running a beam on the warper; we have a board; and every time a thread breaks in running a girl makes a mark. There is a line drawn through

of the black-board, and we put the number of the spool-attender above or below; and there is a mark put down against her number every time the thread breaks in warping. And I can say we have less ends broken on the seven-inch traverse and two-inch ring than we do on the other. And we also keep a record in the weave room. I have two weavers go in Monday morning, one in the north end and one in the south end of each of our large weave rooms; and each is given a paper like this I hold in my hand, and she marks down the number of ends that are broken during the week on the last full warp that was put into her looms. And we have less breakages in weaving on the seven-inch traverse and the two-inch ring than we do on the other. We have nothing shorter than the six-inch and the inch and three quarters. I do not know of any other differences that would be worth anything to us. I think, if anything, the lighter the traveller you use in spinning, the more fuzzy the yarn looks; but it weaves better with the long traverse and large ring.

There is one thing I might say about power. This report that I gave you on power is not the power in our mill. We drive in our mill about eighty-two spindles per horse-power, with six-inch traverse and inch and three quarters ring. This that I gave you was sixty-eight and seventy-two; seventy-two with the five and one half inch traverse and sixty-eight spindles with the six-inch traverse. In our mill, for some reason, the lightness of the bobbins or something else, — I do not know exactly how, — but, as shown by experiment, we have been enabled to drive, on an average, eighty-two spindles per horse-power.

The President. Is there any other member who would like to say a word on this subject? It is something that is very important.

A Member. I would like to ask Mr. Bourne how much it costs him to spool his seven-inch traverse.

Mr. Knight. I would like to put it another way and ask him how much he has saved.

The PRESIDENT. Will you please answer the questions, Mr. BOURNE? Answer both of them, please.

Mr. BOURNE. Well, we were running formerly what Mr. KNIGHT has been advocating; namely, a six-inch traverse and inch and three quarters ring —

Mr. KNIGHT. Not on twenty-eight yarn?

Mr. BOURNE. No; not on twenty-eight yarn, but from twenty-twos to coarser. And we have made a change from an inch and three quarters ring to a two-inch ring and a seven-inch traverse; and we save fully half the doffing and one half the expense of spooling. And that, in a coarse mill, is quite an item. For you fellows running on very fine numbers, it would not be worth talking about. But we spool by the job, of course.

The PRESIDENT. I presume they are drifting, in most mills, in that direction; to larger rings and a longer traverse.

Mr. BOURNE. I do not think it would have been possible to do it without the improved separator. We must have the latest separator, I think, — such an one as made by the DRAPERS, or the Lowell Machine Shop. I do not think we could do it with one of the old ones. This has made it possible to change to the longer traverse.

Mr. KNIGHT. I will say that the separator we use is three and one half inches wide.

The PRESIDENT. If there is nothing more to be said on this topic, we will pass to the next; "Methods of making up Costs." Mr. HENRY F. LIPPITT, of the Manville and Social Manufacturing Companies, if he is present, will open the subject.

METHODS OF MAKING UP COSTS.

By Mr. HENRY F. LIPPITT, Providence, R. I.

This subject of making up costs is a matter which, under the old methods of manufacturing, was quite a simple one. Where there was but one grade of cotton, one or two numbers of roving, and perhaps three or four numbers of yarn, and three or four styles of goods woven, it was very easy to take a system of averages and get your pounds of cloth; and from your pounds of cloth find the cost per pound of each of the different departments; and call that the cost of manufacturing the goods. But since the diversity of manufacturing that prevails to-day has come in, those averages are very deceptive; in fact, they are so deceptive that they are not only useless, but they are dangerous, because, as often occurs in relying on averages, the man who has charge of selling the goods of a mill either sells a high cost style of goods for too low a price, or he refuses a contract on a low-priced article because he thinks he cannot afford to make it at the price; when, if the thing had been figured out accurately, he would discover that he should not sell the high contract, and he should sell the low one, both to the advantage of his mill.

In trying to carry out the principle of finding out accurately the cost of each style of goods, we have gone to a good deal of labor. And, to begin with, we have taken the fixed charges of the mill, such as the taxes and insurance, and assigned them to their different departments in proportion to the value of the machinery, etc., in the different departments. The power has been assigned to the different departments in proportion to the amount of power that is used in each. The office

expenses have been assigned, and the other fixed charges have been divided up in such ways as seem in each instance most proper. We then started with the carding room and carefully figured the cost of each number of roving on the basis of what it would cost if the mill was making only that number of roving. Perhaps I ought to say here that I am talking of a mill where the extreme variation in the numbers of yarn made is as much as fifty, perhaps, and where the variation in the count of the goods is often from one hundred and fifty to two hundred threads to the square inch; that is, it goes from perhaps a fifty-six square in one case to goods counting 96 x 200 and above in the other. So you can easily see, not only that they are using different grades of cotton, not merely that they are putting different grades of cotton into different numbers of yarn, but even putting different grades of cotton into the same number of yarn, in accordance with the purpose for which it is to be used. For instance, in making forty warp, if we were going to put in a light weave, we would make it out of an inch and one-eighth cotton; if in a very severe weave, out of an inch and three-eighths cotton. So it will not do even to take the number of yarn and figure the cost on an average. We have got to consider all the elements that enter into it. As I was saying, we take the carding room and figure it out for each number of roving that is made, on the basis of what it would cost if the carding room made that number of roving alone. And we add to it the cotton that that number of roving is made out of, and add to it its proportional part of the fixed expenses that I have already spoken about. We then have a statement, or a list, of the cost of each number of roving. We then take the spinning department, the spinning and mule room, and figure the piece-work cost of each number of yarn, and add to it its proportional part of the fixed expenses; add to that the cost of the particular kind of roving out of which it is made, and we have the cost, so far, of our different numbers of yarn. We then take our various kinds of goods and figure carefully the proportion of warp and filling that there is in them; and, of

course, knowing the cost of these yarns, we get at the cost per pound for the yarns of the goods. We then add to that the cost of weaving, and the proportional part of the fixed expenses that have been charged to the weave room, and, in that way, get the cost of the particular style of goods that we have under consideration. This cost is then put upon a report that is sent to the office, that is, to the selling department, which is all that they have in regard to the cost of the goods. This report consists of columns which give a description of the goods of course, the pounds per loom per day, and the cost per loom per day, as has already been explained, I hope, intelligibly. On that is put, at the office, the price at which we sell the goods, and a column is then put down which shows the receipts of each loom in comparison with the cost for running each loom; and the difference between the two constitutes the profit, which is also put here. We also figure it up on the basis of the cost and receipt per pound, and have the profit per pound. We suppose it is a profit. In these times it does not always turn out that way; but, heretofore, it has been a profit. So that the final report which is made use of in selling the goods is a sheet like that, which simply shows the cost per loom and the cost per pound, the receipts per loom and the receipts per pound, and the profits per loom and the profits per pound. Of course the profit per loom or the profit per pound amounts to the same thing. It is merely another way of expressing the same thing; but it is sometimes convenient to have it in both forms. Now, in figuring up a report like that in a mill with a large number of styles (we have about one hundred), it is a very elaborate process, and it cannot be done by a mere clerk. It has to be overlooked very carefully by somebody who knows exactly what class of yarn is being put into the different styles, and what class of roving the different numbers of yarn are made out of, and all the other particulars. It takes a great deal of time to do it, and is so elaborate that we only do it about once a year. We also have monthly reports in which we merely put the cost of the goods, the weaving of the goods,

and the number of yarn out of which they are made, and use that very largely for comparative purposes. I do not know whether I have made myself clear or not. I would be very glad to answer any questions anybody may care to ask.

A MEMBER. I would like to ask him what he considers the difference of cost between spinning 40s yarn from an inch and an eighth stock, and 40s yarn from an inch and a half stock.

Mr. LIPPITT. Mr. Chairman, that is so largely a question of figures that I would not like to attempt to answer it. Of course in spinning No. 40 from long staple cotton, you put in less twist and get some benefit that way. The difference in cost is not the full cost that shows in the difference in the cost of the cotton. It is a matter which it is very easy to figure when you have the proper data before you.

The PRESIDENT. The next speaker on the same topic is Mr. FRANKLIN NOURSE, of the York Manufacturing Company.

Mr. GOODALE. I had a note from Mr. NOURSE stating that he could not be present, and asking me to read his paper for him.

COMPUTATION OF THE COST OF COLORED GOODS.

By Mr. FRANKLIN NOURSE, Saco, Me.

The four general items of the cost of colored goods are: I. MILL EXPENSE, including the various processes from picking through finishing, except dyeing. II. GENERAL EXPENSE. III. DYEING. IV. COTTON.

I. In calculating the Mill Expense, the various processes may be grouped as follows: 1. *Carding;* 2. *Spinning, Spooling, and Reeling;* 3. *Winding and Beaming;* 4. *Quilling;* 5. *Warping, Dressing, and Drawing-in;* 6. *Weaving;* 7. *Finishing.*

1. *Carding.* The different kinds of goods whose costs are desired should be arranged in groups, according to the hank roving used in making their yarns. The cost of making each hank roving from the slubber through the final roving frame having been estimated as nearly as possible, the number of pounds in each group should be multiplied by the cost of its hank roving, and the sum of the products will represent the cost, in the carding department, of all the goods from the slubber to the final roving frame, both inclusive. By subtracting this sum from the total actual cost of carding, as shown by the payroll, the cost of working the cotton from the bale through the drawing frames is obtained, and, assuming that thus far the cotton in all the goods has received practically the same treatment, a cost per pound for this portion of the carding, applying to all of the groups, may be found by dividing the cost heretofore obtained by the total number of pounds in

all of the goods. To this cost per pound is added the cost of making the hank roving distinguishing each group, and the total cost per pound of carding in the goods of that group is the result.

2. *Spinning, Spooling, and Reeling.* The different marks or kinds of goods are arranged in groups according to their average count or number of yarn. The pounds in each group are then multiplied by its average number, and the sum of the products will be the number of hanks in the goods. By dividing the actual cost of spinning, spooling, and reeling by the total number of hanks, the cost per hank of these processes is found. The cost per hank multiplied by the average number of yarn of the several groups gives their cost per pound.

3. *Winding and Beaming.* It is first necessary to ascertain the proportional amount of wound or beamed yarn in the different kinds of goods, giving to each kind or mark an average number which shall bear the same ratio to its full average number (*i. e.*, the average number of all its yarn) that the number of wound or beamed threads does to the whole number of threads in the pattern. The goods are then arranged in groups according to these partial average numbers; the pounds in each group multiplied by its average number; and the actual cost of winding and beaming divided by the sum of these products. The quotient multipled by each of the partial average numbers will give the cost per pound of winding and beaming in the goods of each group.

4. *Quilling.* This cost is ascertained by finding the proportional amount of quilled yarn in the different kinds of goods and proceeding as in the case of winding and beaming.

5. *Warping, Dressing, and Drawing-in.* Having ascer
tained the proportional amount (in weight) of the wa
each fabric, *i. e.*, the per cent of warp in the whole clo
same per cent should be taken of the number of yarn i
warp of that cloth, and the result will be the partial a
number to be used in calculating the cost of these pro
The different kinds of goods should then be arranged in

according to these partial average numbers, and the further calculation made as in finding the cost of winding and beaming.

6. *Weaving.* The number of pieces, or cuts, of each kind or mark of goods should be multiplied by the price per piece paid for weaving it. The sum of these products may be assumed to be the total cost of weaving proper. The difference between this sum and the total weaving payroll represents the general expense of that department. Whatever per cent this general expense is of the cost of weaving (proper) as previously found, should be added to the various partial costs of weaving in order to get the total cost of each mark in the weaving room. By dividing the total cost of each mark by the number of pounds of that mark, the cost per pound is obtained.

7. *Finishing.* Unless certain cloths have special treatment in finishing, it may be assumed that all the goods go through substantially the same processes in the cloth room, and that the cost per yard of finishing each kind is the same. By dividing, then, the cloth room pay-roll by the total number of yards, and multiplying the quotient by the number of yards to the pound in each kind of cloth, the cost per pound is ascertained. If special processes are used for certain goods, their expense should be kept separate, divided by the pounds of cloth thus treated, and the cost resulting added to the general cost per pound as found above.

II. General Expense. — This may be found in various ways, but perhaps as convenient a method as any, and one not far from the actual cost, is to find what per cent the total general expense is of the total mill expense, and then take that per cent of the mill expense per pound of each kind of goods, the result being the general expense per pound.

III. Dyeing. — The cost of producing each color has first to be ascertained by multiplying the pounds of each kind of dyestuff used in coloring a given quantity of cotton, say one hundred pounds, by its market price, and dividing the sum of the products by one hundred, or the number of pounds of

cotton colored. To the result are added the labor per pound of dyeing and the general expense per pound of the dye-house, and the total will give the cost of applying that color to one pound of cotton. Having ascertained the costs of the various colors, it is necessary to find the cost of dyeing each pattern of each kind of goods. This is done by counting the number of threads of each color in the warp of the pattern, multiplying the number found by the cost of its color, and dividing the sum of the products by the total number of threads in the pattern. The filling is treated in the same way, and the two costs, that of the warp and of the filling, are then averaged according to the proportion, in weight, of warp and filling in the pattern. The costs of the various patterns in each kind of goods are then averaged according to the proportional quantity of each pattern, and the result is the estimated cost per pound of dyeing in that kind of goods. To bring these estimated costs more nearly to the actual, it will be necessary to add to or take from the estimated costs a certain per cent. This per cent is ascertained by multiplying the number of pounds of each kind of goods by its estimated dyeing cost per pound, the sum of the products being the total estimated cost of dyeing. The difference between this total and the actual total cost of dyeing (omitting the cost of fuel) is then found, and whatever per cent this difference is, of the total estimated cost of dyeing, is the per cent necessary to be added to or taken from each estimated cost per pound in order to make it the actual cost. The cost of fuel in dyeing has not been included in the preceding calculation, as it is more convenient, and perhaps n
far from right, to add to each dyeing cost previousl
charge ascertained by dividing the cost of fuel use
by the total number of pounds produced.

IV. Cotton.—As some cloths are made c
poorer cotton than others, or contain more or le
well to arrange the different kinds of goods in g
ing to the value of cotton in them, giving to th
the value of zero, and to each succeeding highe

value as will equal the difference, estimated as carefully as may be, between the cost of the cotton in it and that of the cotton in the lowest group. The pounds in each group are then multiplied by its differential value, and the sum of the products subtracted from the net total amount charged to cotton in the goods. The remaining difference, divided by the total pounds in all the goods, will give the cost per pound of cotton in the lowest group. By adding to this cost the differential value of each of the other groups, its cost per pound of cotton is found.

The sum of the various costs thus ascertained is the total cost per pound of each of the different marks or kinds of goods. By dividing these costs by the number of yards to the pound in each kind, the costs per yard are reached.

The costs thus obtained cover only expenses at the mill. If a cost is desired to include everything, or on which to base an asking price, there should be added to the mill costs such a *per cent* as will cover commissions, treasurer's expenses, etc., and — as much more as one thinks his selling agents can stand.

It is not claimed that the method here outlined gives results that are absolutely correct, in fact some parts of it are confessedly employed for greater convenience and brevity, but the figures are approximately near the actual; and in getting the comparative costs of different kinds of goods, fairly close results may be obtained.

The PRESIDENT. As Mr. NOURSE is not here to answer any questions, we will pass on to the next speaker on the same topic, Mr. R. W. EATON, of the Cabot Manufacturing Company.

Mr. EATON. I will read my paper now; although it does not give you another idea beyond what Mr. LIPPITT gave you.

METHOD OF COMPUTING COSTS.

By Mr. R. W. EATON, Brunswick, Me.

I assume that we wish to outline a plan of procedure for determining, in a mill making several cloths, the cost of producing any one of them, and from the figures obtained to lay out a system of calculation by which the cost of any other cloth, somewhat similar, may be ascertained.

Also, in a mill making one style of cloth or a few very similar ones, to ascertain from the cost of these, the probable cost of making a quite dissimilar cloth in the same mill.

In my first division I assume that an analysis is needed to determine out of the total figures what apply to the particular products. My method is this: I examine the picking and carding and try to determine the amounts or proportions due to each variety of roving produced, and get as close a cost as possible per pound for each kind of roving made.

I do the same in the warp spinning room. These costs should be such that multiplying the number of pounds of each kind of roving or yarn, by your assumed cost per pound of each, would give the actual cost of that room; and if you find this to hold true in your room when another proportion of numbers is being made, it might be called a test, I suppose. Then I take the spooling and the warping and the slashing.

Now, let us do the same with the mule spinning; we wi find a different cost for say No. 32 warp on a beam read draw in than we will for No. 32 weft. Assume that we l obtained the following costs: —

WARP.		WEFT.	
No. 25 . . .	18.20c.	No. 25 . . .	16.4
No. 28 . . .	19.00c.	No. 31 . . .	17.50
No. 32 . . .	19.75c.	No. 37 . . .	19.0
No. 34 . . .	20.50c.	No. 40 . . .	19.7

One branch of the business is now done. The weave room now buys these yarns, we will say, from the spinning, and the prices are of some help to us when we buy yarn of others.

Now, a piece of cloth is shown for calculation of cost. I ascertain the amount of warp and weft in a yard of it. Multiply the amounts by their costs as given above; add the cost of drawing in, the cost per yard of weaving, the cost per yard to cover the fixed charges applicable to the weave room, and I have I think the cost of the goods.

Let us examine a piece of cloth in this line: —

Assume 76 x 80 — 28 warp, 40 weft, weighing four yards per pound.

Warp .144 (lb. per yard) x 19.00c. . . .	2.736c.	
Weft .106 (lb. per yard) x 19.75c. . . .	2.094c.	
	———	4.830c.
Web Drawing 28c. for 700 yards		.040c.
Weaving 50c. for 50 yards		1.000c.
Fixed charges, $4 per loom, at 160 yards per loom per week		1.25c.
Total cost . . .		7.120c.

My second division was to ascertain the probable cost of a cloth dissimilar to those now being made. The discussion of this I wish to omit, except to say that instead of calculating by so much per number, the probable costs would be obtained in each room from the probable production, following substantially the lines of the other division; assumptions taking the place of actual results.

The President. If any of the members desire to ask Mr. Eaton any questions, they now have an opportunity. If not, we will pass on to the next paper on the same topic, by Mr. John Holland of the Cocheco Manufacturing Company.

Mr. Walter E. Parker. Mr. President, Mr. Holland is not able to be present, and asked me to read his paper.

METHOD OF MAKING UP COST OF GOODS IN A PLAIN MILL.

By Mr. JOHN HOLLAND, Dover, N. H.

This question is a very important one, and is simply dependent on how much detail is used in keeping the accounts. My system gives me the cost of goods manufactured, without going into details that could easily be considered, but which, for my purpose, are unnecessary.

I would suggest that a committee be appointed at this meeting to provide standard methods of computing costs. The American Society of Mechanical Engineers has, during its existence, rendered great assistance in the mechanical arts by having committees appointed for the purpose of providing standard gauges of various kinds. The reports of these committees, after being accepted, are adopted as a standard throughout the United States.

Following this plan would it not be well for the Board of Government to appoint a committee to make standard methods of cost, using as part of their material, the various papers on methods presented at this meeting, and obtaining such other data as may be necessary?

My method is to first get the labor cost per hank in picking, carding, spinning, dressing, and weaving. For the picking, carding, and weaving use the average number of the mill. For the warp spinning and the dressing use the average number of the warp. For the filling spinning use the average number of filling. The cost in dollars and cents of each department is divided by the pounds put through said departments. The resulting cost per pound is divided by the average numb[illegible] the cost per skein.

In arriving at the average number, I figure skeins [illegible] of warp and filling of each kind of cloth [illegible]ufactur[illegible]

tiply the yards made by the skeins per yard of warp and filling. This gives total skeins of warp and filling, and adding the warp and filling skeins together, gives the total skeins of the mill. This sum divided by total pounds manufactured, gives the average number of the mill.

For costs of weaving, the cuts of each kind of cloth manufactured are multiplied by the price per cut of weaving. The difference between the sum of these amounts and the weaving room pay-roll is the general expense of weaving, or the day labor. This total cost is divided by the pounds manufactured, and then by the average number, giving cost per skein.

Next come the incidentals, which include all other expenses whatsoever, and these, of course, can be sub-divided at pleasure, but for the purpose of this example they will be considered together.

These incidentals include cloth room, repairs, and improvements, fuel, engineer and firemen, yard hands and watchmen; supplies of all kinds, including gas, oil, and starch; general expense including salaries and taxes. The sum of these incidental expenses, divided by pounds manufactured, and again by the average number, gives the cost per skein of incidentals.

In figuring the cost of cotton, I take the invoiced cost first, and then ascertain the net waste of the mill. This gives the cost of cotton per pound in the cloth, and this divided by the average number, gives the cost of cotton per skein.

In sub-dividing the cost, as just given, to ascertain the cost of one kind of cloth, I proceed as follows: —

Multiply the cost per skein of carding by the number of skeins per yard in the kind of cloth being figured. This gives the cost per yard of carding.

The cost per skein of warp spinning multiplied by the number of skeins of warp per yard in the kind of cloth being figured, gives the cost per yard of warp spinning.

The cost of filling spinning per skein multiplied by the number of skeins of filling per yard in the kind of cloth being figured, gives the cost per yard of filling.

The cost of dressing per skein multiplied by the number of skeins of warp per yard in the kind of cloth being figured, gives the dressing per yard.

The cost of weaving per skein multiplied by the total number of skeins per yard in the kind of cloth being figured gives the cost of weaving per yard. The sum total of these amounts gives the cost of labor per yard. The cost per skein of incidentals multiplied by total number of skeins per yard gives the cost per yard of incidentals.

The cost of cotton per skein multiplied by total number of skeins per yard, gives the cost of cotton per yard.

The grand total of these amounts gives mill cost per yard.

To compute cost I use this rule: —

Divide sum of sley and picks per inch, by *sum of sley divided by number of warp, and pick divided by number of filling.*

Multiply quotient by cost per skein for labor and incidentals. Add to this product the cost per pound of cotton in the cloth, the sum thus obtained giving cost per pound.

To determine cost per yard, divide cost per pound by yards per pound.

Example for cloth five yards per pound, sixty-eight sley, seventy-two picks, No. 28 warp, No. 36 filling, assumed cost per skein three mills, cotton in the cloth eight cents per pound: —

$$\left[\frac{68 + 72}{\frac{68}{28} + \frac{72}{36}} \quad .003 + .08\right] \div 5 = \quad .08496 \text{ per yard.}$$

For a short method of estimating cost per yard of a piece of goods to be made, I find the average number, *yards per pound*, and cost of cotton in the cloth.

The cost per skein for labor and incidentals of similar go[illegible] being known by the method described, add to cost per po[illegible] of cotton the product of cost per skein and average num[illegible] and divide by yards per pound.

What I have given is a method that answers all practical purposes for a plain cloth mill. An ideal method would be something as follows: —

Consider each department of the mill as a customer having an account with the mill. You would then debit each department with what was used in the department and credit it with the finished product, thus arriving at the cost of each department in dollars and cents, and this could easily be converted into cost per pound, hank, or yard. For instance, take carding: you would debit carding, first, with so much raw cotton, card clothing, roving cans, roll covering, brooms, pails, oil, gas, power, and everything of any kind or nature used by the carding room, including amount paid for labor. You would credit the carding room with the pounds of finished product turned out by that room, also the waste made in the room. The spinning room would be debited with the product of roving delivered same, and all supplies, etc., and credited with its production, — carrying this throughout each department.

The PRESIDENT. Does any member wish to ask a question? I have an idea that Mr. PARKER is ready to defend Mr. HOLLAND'S paper.

Mr. PARKER. Perhaps it might be as well right here to refer to a suggestion made in both Mr. MESSENGER'S and Mr. HOLLAND'S paper. Each one suggests the appointment of a committee to consider the question. I think the suggestion is a good one; and as I stand, in a measure, for those papers, I do not want the meeting to adjourn without considering their suggestion. And I move you that Mr. MESSENGER'S suggestion that a committee be appointed, and that committee to be appointed by the Board of Government, be carried out. I make the same motion in regard to Mr. HOLLAND'S suggestion.

The motion was seconded, and unanimously carried without debate.

The PRESIDENT. We will now hear from Mr. NICHOLS who has consented to read the paper of Mr. THOMAS who is absent.

METHOD OF OBTAINING MILL COSTS IN COTTON FLANNEL MILLS.

By Mr. E. W. THOMAS, Lowell, Mass.

The great variety of goods made, and the peculiar organization of the same, regarding the proportion of warp and filling yarns required in their construction, together with the great range of yarns spun, render it of extreme importance to the manufacturer of cotton flannels to adopt the best available method to ascertain the nearest practical cost of all the classes and grades of goods he may make. To this end the writer has given much personal attention, and presents the following system as one that is, in his opinion, a thoroughly practical one.

There are in use, at the Tremont and Suffolk mills, what are termed "cost blanks"; these blanks are made out by the different overseers each month, giving the production in pounds of each number of roving and yarn, etc., made in their department, as well as the amount of money expended on each operation in their respective rooms. The blanks are introduced below, showing the method of filling them in, and the figures represented on these blanks will be referred to later on in working out the cost per pound of cloth.

Blank A is designed for use in carding room, and [illegible] actual production and costs per pound of the ou[illegible] department.

Blank B is designed for warp spinning depa[illegible]

Blank C is designed for filling spinning dep[illegible]

Blank D is designed for spooling departme[illegible]

Blank E is designed for balling, beami[illegible] department.

Blank F is designed for warping and dressing department.
Blanks G and H are designed for dye house department.
Blank I is designed for weaving department.
Blank J is designed for napping department.
Blank K is designed for cloth finishing department.

A.

NO. 2 CARD ROOM, NO. 4 MILL.

Cost per pound of Fine Roving, for Four Weeks, ending July 29, 1893.

No. of Roving.	60/100	1.00	1.50	2.	2.75	6.
Warp or Filling.....	Filling	Filling	Filling	Filling	Warp and Filling.	Warp.
Lbs. Roving made.....	31,627	168.900	348.768	16,178	308,638	167,889
Wages.						
Single Carding.....	$49 60	$209 94	$433 52	$24 88	$487 82	$268 30
R. W. & D. F.....	25 00	106 75	220 42	12 64	254 07	139 94
Coarse Speeder.	19 77	202 97	145 79	21 51	305 63	235 13
Inter Speeder	-	-	-	-	-	300 30
Fine Speeder.....	-	-	378 53	21 00	550 04	690 63
Gen. Room Expenses...	42 11	176 00	363 42	21 00	443 09	246 67
Total Wages.....	$136 48	$695 66	$1,541 68	$101 03	$2,040 65	$1,880 97
Cost per pound.....	.0043	.0041	.0044	.0062	.0066	.0112

B.

NO. 2 WARP SPINNING ROOM, NO. 6 MILL.

Cost per pound for Warp Spinning, for Four Weeks, ending July 29, 1893.

No. of Yarn.	20	30
Number Spindles Run.....	6,182	23,904
Pounds Spun.....	48,538	142,546
Wages.		
Doffers.....	$79 02	$285 64
Spinners.....	99 37	855 16
General Room Expenses.....	101 47	408 68
Total Wages.....	$379 86	$1,549 48
Cost per Pound.....	.0078	.0108

C.

NO. 1 FILLING SPINNING ROOM.

Cost per pound of Filling, for Four Weeks, ending July 29, 1893.

No. of Yarn.	2 1-2	3 1-2	5 1-2	9	14	18	26
No. Spindles Run...	334	629	1,634	2,136	6,015	1,561	6,569
Lbs. Spun.....	22,307	40,531	61,277	37,899	68,221	12,675	40,076
Wages.							
Spinners.....	$15 03	$70 36	$92 23	$86 38	$236 48	$59 48	$274 09
D. and B. Boys.....	35 12	52 16	141 21	80 72	205 13	32 00	137 64
Gen. Room Ex.....	17 33	14 01	97 45	52 42	150 07	31 22	125 38
Total.....	$67 48	$141 70	$330 89	$219 52	$591 68	$122 70	$537 11
Total Cost per Lb.	.00304	.0031	.0054	.0058	.0086	.0096	.0134

D.

SPOOLING DEPARTMENT.

Cost per pound for Spooling, for Four Weeks, ending July 29, 1893.

No. of Yarn.	20	30
Pounds Spooled	219,042	138,167
Wages.		
Spoolers.....	$655 34	$502 04
General Room Expenses.....	103 60	65 30
Total Wages.....	$758 94	$567 34
Cost per Pound.....	.0034	.0041

E.

BALLING, BEAMING, AND QUILLING.

Cost per pound for Balling, Beaming, Quilling, etc., Four Weeks, ending July 29, 1893.

Yarn No.	Pounds.	Balling.	Beaming.	Cost per Pound.
20	45,624	$150 56	-	$0 0033
30	8,961	45 70	-	0051
20	41,039	-	$434 28	0105
30	10,486	-	147 70	0145
Total Cost.	-	$196 26		
Total Lbs.	-	54,585	51,525	

F.

WARPING AND DRESSING DEPARTMENT.

Cost per Pound for Warping and Dressing, for Four Weeks, ending July 29, 1893.

Marks.	Lbs. Warped.	Wages Warping.	Wages Dressing.	Wages Drawing in.	General Room Exp.	Total Wages.	Cost Per Lb.
X	18,280	$14 98	$13 11	$25 20	$26 68	$79 97	.0042
XX	23,752	19 47	20 91	45 30	34 67	120 35	.0050
XXX	58,280	75 69	52 16	104 21	85 01	317 07	.0054
XXXX	7,388	9 60	8 71	9 33	10 78	38 42	.0052
A, B	56,556	46 37	33 23	52 62	82 57	214 79	.0037
C	8,229	6 74	4 48	7 00	12 01	30 23	.0036
CS	51,128	20 24	93 55	111 96	75 99	301 74	.0059
DG	9,329	3 64	18 17	33 73	13 62	69 16	.0074
Totals	232,892	$196 73	$244 32	$389 35	$341 33	$1,171 73	-

G.

DYE HOUSE.

Cost of Dyeing Warp and Filling Yarns, Four Weeks, ending July 29, 1893.

Color.	Lbs. Dyed.	Cost of Drugs and Dyes.	Cost of Labor.	Total Cost.	Cost per Lb.
3 Slate	212	$2 33	$1 63	$3 96	.0186
14 Blue	5,600	22 96	42 54	65 50	.0118
3 Brown	3,249	64 98	25 01	89 99	.0277
1 Tan	1,567	9 71	12 08	21 79	.0139
3 Electric	2,225	25 81	17 13	42 94	.0183
1 Yellow	878	60	6 75	7 35	.0084
Total	13,631	$126 39	$105 14	$231 53	.0170

H.

DYE HOUSE.

Cost of Dyeing Raw Stock, Four Weeks, ending July 29, 1893.

Color.	Pounds.	Cost of Drugs.	Cost of Labor.	Total Cost.	Cost per Pound.
Blue "P"	10,320	$207 43	$56 76	$264 19	.0256
Blue "R"	4,512	11 73	24 81	36 54	.0081
Drab	2,003	84 12	16 54	100 66	.0475
Yellow	2,759	41 38	15 17	56 55	.0205
Red	7,098	157 57	39 03	196 60	.0277
	26,692	$502 23	$152 31	$654 54	.0245

I.

NO. 8 WEAVE ROOM, NO. 7 MILL.

Cost per Pound for Weaving, for Four Weeks, ending July 29, 1893.

Marks.	Lbs. Woven.	Wages. Weavers.	General Room Exp.	Total Wages.	Cost per Lb.
X	12,056	$155 93	$29 17	$185 10	.0153
XX	2,817	42 73	6 33	49 06	.0170
XXX	17,847	385 31	71 98	457 29	.0256
XXXX	4,381	103 79	19 40	123 19	.0281
A	73,321	2,202 13	180 84	2,382 97	.0325
B	9,988	214 24	21 92	236 16	.0236
C	7,167	119 79	6 85	126 64	.0177
CS	88,472	2,026 44	304 08	2,330 52	.0263
DG	21,867	1,261 76	202 76	1,464 52	.0670
Totals.					

J.

NAPPING DEPARTMENT.

Cost per Pound for Napping, for Four Weeks, ending July 29, 1893.

Marks.	Lbs. Napped.	Wages. Nappers.	General Room Exp.	Total Wages.	Cost per Lb.
X	8,287	$7 12	$5 66	$12 78	.0015
XX	17,905	19 13	15 21	34 34	.0019
XXX	11,294	16 35	12 99	29 04	.0026
XXXX	1,663	3 51	2 79	6 30	.0037
A	59,416	36 00	36 00	72 00	.0012
B	9,634	6 71	5 75	12 46	.0013
C	1,968	1 09	94	2 03	.0010
CS	101,795	112 03	88 99	201 02	.002
DG	4,789	6 92	5 41	12 33	.0026
Totals					

K.

CLOTH ROOM.

Cost per Pound of Cloth Finished, for Four Weeks, ending July 29, 1893.

Mark.	Pounds.	Cost per Lb.	Amount.
X	33,097	.0014	$46 33
XX	21,182	.0022	46 60
XXX	51,446	.0029	149 19
XXXX	4,553	.0037	16 84
A	38,818	.0061	239 84
B	11,034	.0035	39 31
C	5,742	.0026	14 97
CS	95,825	.0034	333 46
DG	23,197	.0045	105 97

It is to be understood that the productions given in the foregoing tables do not represent the total output of the mills, nor of the rooms; nor do the amounts in the cost-per-pound columns represent the actual costs at these mills; but the figures *do* represent an actual approximate cost with which to show the method of computing the total cost of the goods.

The letters referred to in blanks F, I, J, and K, represent some of the various goods woven at these mills; and the numbers of rovings and yarns represented in other blanks are selected because they enter into the construction of these grades of cloth.

In further explanation of these cost blanks, it will be observed that the cost per pound is, in each case, figured strictly on the reported output of the room.

These productions as represented are naturally from many causes larger than the final output of the mill, hence, the reported cost per pound on each operation is somewhat less than the actual cost. Each six months the productions from each department are carefully compared with the final output of the mill, and percentages of the shrinkage obtained.

For the six months during which the cost blanks represented above were made, the following figures show the percentage shrinkage in total production of mill, as compared with the productions given in the various departments: —

Cloth Finishing Department	. . . . .	1%
Napping	"	1%
Weaving	"	2 1/4%
Warping and dressing	"	11 3/10%
Spooling	"	1%
Warp spinning	"	4%
Filling "	"	113/10%
Warp carding	"	4 3/10%
Filling "	"	15 1/2%
Balling and beaming	"	6%
Dyeing and drugs	"	20%

That is, to the costs per pound of each operation represented on the foregoing cost sheets, the per cent specified for that department should be added, to get the cost per pound on net product of mill.

For example, referring to cost sheet A, it is found that the overseer's cost per pound of No. 2 hank roving is .0062 cents; as this number of roving is used for filling, we find the per cent to be added to this cost to be fifteen and one half per cent. Adding fifteen and one half per cent to .0062 = .00716, which represents the labor cost per pound of No. 2 hank roving.

Or, for example, to obtain cost of No. 30 warp yarn, we find, per cost sheet B, No. 30 yarn costs .0108 per pound, the percentage to be added in this case would be four. Four per cent of .0108 = .00043, added to .0108 = .0112; so that the cost of No. 30 warp yarn per pound is .0112.

Now having all the cost sheets before us, and the means of computing the net cost per pound of each operation, we are enabled to obtain the cost of any one or more of the various goods being made. To illustrate more fully it is proposed to find the labor cost of four various weights of cotton flannels, viz., X, XX, XXX, XXXX, three different weights of blankets, viz., A, B, C, and two different weights of colored goods, viz., CS and DG. And to incorporate the various elements in these goods, so that they may be readily and quickly seen, the following table has been prepared, which will be called table

L.

Marks on Goods.	No. Warp Roving.	No. Fill. Roving.	No. Warp. Yarn.	No. Fill. Yarn.	% Warp. in Cloth.	% Fill. in Cloth.	Yds. Per Pound.	Lbs. Per Pair Blankets.	Lbs. per Loom per Week.
X	2.75	1.00	20	5 1/2	32	68	2		83
XX	2.75	1.50	20	9	38	62	3		75
XXX	6.	2.	30	14	45	55	4		48
XXXX	6.	2.	30	18	58	42	5		41
A	2.75	1.00	20	5 1/2	30	70		[illegible]	
B	2.75	60/100	20	3 1/2	15	85			
C	2.75	60/100	20	2 1/2	17	83			
CS	2.75	2.	20	14	46	54			
DG	6.	2.75	30	26	51	49			

It will be seen throughout this paper
on the pound of cloth rather than by
costs are given as hundredths of a cen

The cost of picking per pound, bei

of goods, is found by dividing the amount of pay-roll of this department by the net pounds invoiced from mill. At this point it is well to state that all the picking at these mills is in one building and under superintendence of one man. At these mills the cost for picking is one mill per pound of finished product.

Taking for example the X cloth and desiring to find the labor cost, having determined the cost of the picking, the next element to consider is the cost of warp carding. The roving for the warp yarn in this grade of goods (see table L) is No. 2.75, which cost per pound (see cost sheet A) .0066, to which add four and three tenths per cent for shrinkage = .00688, as being the net cost per pound of No. 2.75 hank roving, but as there is only thirty-two hundredths of a pound of warp in a pound of X cloth (see table L), then the amount of labor represented by the warp carding would be but thirty-two hundredths of .00688 which is .0022. The filling roving of this cloth is found to be No. 1.00 hank (see table L) its cost per pound (see cost sheet A) is .0041, to which add for shrinkage fifteen and one half per cent = .0047 cost per pound, but as there is only sixty-eight hundredths of a pound of filling in the pound of X cloth (see table L) then the amount of labor represented by filling carding, would be but sixty-eight per cent of .0047 = .0032. We find next the warp yarn in X goods to be No. 20's (see table L) its cost per pound (see cost sheet B) is .0078, and add to this the percentage for shrinkage, four per cent, and we obtain .0081 as the net cost of No. 20's warp yarn. X cloth contains but thirty-two hundredths of a pound of warp, hence the cost of the warp yarn will be but thirty-two hundredths of .0081 which is .0026. The number of the filling yarn in X goods is No. 5½ (see table L) and its cost per pound (see cost sheet C) is .0054, to which add eleven and three tenths per cent for shrinkage and the result is .00601 as the net cost per pound. There being but sixty-eight hundredths of a pound of filling in a pound of X cloth then the cost of filling spinning in these

goods would be but sixty-eight hundredths of .00601 which is .0041. The cost of spooling No. 20 warp (as per cost sheet D) is .0034, adding one per cent for shrinkage and we get .00343 net cost of spooling per pound, as but thirty-two hundredths of a pound is used per pound of cloth, then the cost of spooling in X cloth is represented by thirty-two hundredths of .00343 which is .0011. The cost of warping and dressing X warps is (per cost sheet F) .0042, adding eleven and three tenths per cent, percentage for shrinkage, makes the cost .00467, and as there are but thirty-two hundredths of a pound of warp in a pound of X cloth, then thirty-two hundredths of .0042 represents the labor cost of warping and dressing, equals .0015. The cost of weaving X cloth (per cost sheet I) is .0153, to which add the percentage of shrinkage, two and one quarter per cent, makes .01564 as net cost of weaving. The cost of napping X cloth (see cost sheet J) is .0015, to which add one per cent for shrinkage and .00151 is obtained as cost of napping. The cloth finishing cost of X cloth is .0014 (see cost sheet K) to which add one per cent for shrinkage and .00141 is obtained as cost of finishing.

We have now all the elements in the make up of the cost of X cloth, viz. : —

First.	Picking	.001
Second.	Warp Carding	.0022
Third.	Filling carding	.0032
Fourth.	Warp spinning	.0026
Fifth.	Filling spinning	.0041
Sixth.	Spooling	.0011
Seventh.	Warping and dressing	.0015
Eighth.	Weaving	.0156
Ninth.	Napping	.0015
Tenth.	Cloth finishing	.0014
	Total labor of cost per pound	.0342

The costs of the various other classes of good[illegible] in the tables, are figured out in the same manner, a[illegible]dy of table L will fully explain the numb[illegible] the ro[illegible] num-bers of yarns used in the diffe[illegible]ods, a[illegible]tive

proportions of warp and filling in each. The only exceptions, to the above, are where any portion of the warp or filling is dyed, either as raw stock or in yarn, the costs of these operations being shown fully on cost sheets G and H.

In the costs of the three kinds of blankets, A, B, and C, a certain portion of the filling is dyed in raw stock, and in CS and D G goods, certain per cents of the warp yarns are dyed. These percentages are given below, and will be designated as table

M.

In A blanket, eight per cent of the filling is colored.
In B blanket, ten per cent of the filling is colored.
In C blanket, twelve per cent of the filling is colored.
In CS goods, fifty-four per cent of the warp is colored yarn.
In DG goods, fifty per cent of the warp is colored yarn.

To work out cost of the colored goods we will take for example CS. The picking as before explained is .001 per pound. The cost of the warp carding, the roving being No. 2.75 (per table A), plus four per cent for shrinkage and forty-six one hundredths of a pound being in a pound of cloth is .0032. The cost of filling carding, the roving being No. 2, is (per cost sheet A) .0062, adding fifteen and one half per cent shrinkage, equals .0072, fifty-four one hundredths of this being .0039, representing the cost of filling carding. Warp spinning of No. 20's (per cost sheet B) is .0078, to which add four per cent for shrinkage, and the result is .0081; forty-six one hundredths of a pound would cost forty-six one hundredths of .0081 = .0037. Filling spinning, No. 14's, the cost (per cost sheet C) is .0086, to which add eleven and three tenths per cent for shrinkage, and it equals .00957. There being fifty-four one hundredths of a pound of filling in the cloth, then fifty-four one hundredths of .00957 = .0052 as cost of filling yarn in CS cloth. The cost of spooling would be (per cost sheet D) .0034 + 1% for shrinkage, would equal .00343; forty-six one hundredths of a pound would cost forty-six one hundredths of .00343 = .0016. The cost of warp and dressing would be (cost sheet F) .0059 + $11\frac{3}{10}$% for shrinkage, equals .00656.

As there is but forty-six one hundredths of a pound of warp in a pound of cloth, forty-six one hundredths of .00656 would equal .00301 as cost of warping and dressing. The cost of balling and beaming No. 20 warp (see cost sheet E), balling .0033, beaming .0105 = .0138, to which add six per cent for shrinkage; this would be .0146 cost per pound, as only forty-six one hundredths of a pound of warp is in the goods, and only fifty-four per cent of all the warp is colored; then fifty-four per cent of forty-six one hundredths of a pound would equal weight of the warp yarn, in one pound of cloth that is beamed and balled. This equals twenty-five one hundredths of a pound at a cost of .0146 = .0036 as the cost of balling and beaming in one pound of CS cloth. Cost of dyeing and drugs used in No. 20's warp yarn on CS cloth (as per cost sheet G) is .017; add to this twenty per cent for shrinkage, and it equals two cents per pound; as only twenty-five one hundredths of a pound of warp is dyed, then twenty-five one hundredths of .02 = .005 as the cost of dyeing and drugs. The cost of weaving this cloth (see cost sheet I) is .0263 per pound; add two and one fourth per cent, and it equals .0269. The cost of napping the cloth is (per cost sheet J) .002+1% for shrinkage equals .00202. The cost of cloth finishing department on CS cloth (see cost sheet K) is .0034, to which add one per cent for shrinkage, and it equals .00343.

We have now all the elements of labor cost entering into the CS goods, as follows: —

First.	Picking	.001
Second.	Warp carding	.0032
Third.	Filling carding	.0039
Fourth.	Warp spinning	.0037
Fifth.	Filling spinning	.0052
Sixth.	Spooling	.0016
Seventh.	Warp and dressing	.0030
Eighth.	Weaving	.0269
Ninth.	Balling and beaming	.0036
Tenth.	Dyeing and drugs	.005
Eleventh.	Napping	.002
Twelfth.	Cloth finishing	.0034
	Total labor cost	.0625c.

It may not be clear to some why the cost of the warp roving and yarn, and filling roving and yarn, are worked out separately, yet it is of considerable importance that this be done. As for illustration, take a class of goods requiring No. 30 warp by 5½ filling. The roving for No. 30 warp is made on three processes of roving machinery and is No. 6 hank; the roving for No. 5½ filling is No. 1 hank, and is spun direct from slubber roving. This naturally puts considerable expense into the warp carding per pound, over the cost of the filling carding, or to further illustrate, by looking at table N, at the cost of warp carding in X cloth it will be noted it is twenty-two one hundredths of a cent per pound, while the filling carding cost thirty-two one hundredths of a cent per pound, while in DG cloth the warp carding costs sixty one hundredths and the filling only thirty-seven one hundredths. Other extreme peculiarities are also noticeable; for example, in table L, the nearest proportion in weight of warp and filling in any cloth is in DG, where there is fifty-one per cent warp and forty-nine per cent filling, while to the other extreme is C blanket where the warp is but thirteen per cent and the filling is eighty-seven per cent of the weight of the goods. It is in these extreme variations where the foregoing method of computation seems adaptable.

That this system is of no special advantage to the ordinary mill, on plain work and few grades of cloth, is quite evident; and its merit lies more particularly in working out the costs in plants making a large variety of cloth, and notably so where the goods made are of peculiar organization. This system has been in use in colored goods mills with success; and it, or some equally accurate system, should be used by all mills having a diversified output. It is not quite safe, in these days of close management and competition, to use any method based on average numbers or weights; nor to rely on the judgment of any one or more persons, of whatever experience, to "guess" at costs.

N.

OPERATION.	X	XX	XXX	XXXX	A	B	C	C S	D G
Picking	.0010	.0010	.0010	.0010	.0010	.0010	.0010	.0010	.0010
Warp Carding	.0022	.0026	.0053	.0068	.0021	.0010	.0009	.0032	.0060
Filling Carding	.0032	.0032	.0039	.0030	.0033	.0043	.0044	.0039	.0037
Warp Spinning	.0026	.0031	.0051	.0065	.0024	.0012	.0011	.0037	.0057
Filling Spinning	.0041	.0040	.0053	.0045	.0042	.0029	.0029	.0052	.0073
Spooling	.0011	.0013	.0019	.0024	.0010	.0005	.0004	.0016	.0021
Warp and Dressing . . .	.0015	.0021	.0027	.0034	.0012	.0006	.0005	.0030	.0042
Weaving	.0156	.0174	.0262	.0287	.0332	.0241	.0181	.0269	.0685
Balling and Beaming . . .								.0036	.0054
Dyeing and Drugs					.0013	.0021	.0024	.005	.0052
Napping	.0015	.0019	.0026	.0037	.0012	.0013	.0010	.0020	.0026
Cloth Room	.0014	.0022	.0029	.0037	.0061	.0035	.0026	.0034	.0045
Total cost per pound . . .	.0342	.0388	.0569	.0637	.0570	.0425	.0353	.0625	.1162

The foregoing table represents the labor costs of all the various grades of goods referred to in previous tables; giving in detail the labor cost, of each operation, per pound; and is designated as table "N."

To the expenses given in the above table must be added all other expenses incurred at the mill ordinarily called "general expenses." The factors that enter into the proper division and assignment of these general expenses, in mills making a wide range of goods, are the production in pounds per loom, the power required in various departments of the mill, the cost of supplies and repairs, and the value of the machinery employed; and are so difficult to resolve that the writer considers it a problem too intricate to be properly treated in the brief time allotted for the reading of this paper. It is a matter worth close investigation, and, in very few mills, is given the attention it deserves.

The PRESIDENT. You have heard the paper prepared by Mr. THOMAS. Mr. THOMAS has written me that Mr. NICHOLS will answer any question that any member may wish to ask in regard to making up the cost.

If there is no one who desires to ask any questions, we will pass to the next paper on the same topic, by Mr. WILLIAM J. KENT, of the Wamsutta Mills.

Mr. KENT. Mr. President, I wish to state, before reading what I have here, that when this subject was brought up before the Board of Government, it was understood that we should not give figures. Consequently, you will not get any from me. The various kinds of goods which we manufacture vary so that we have to go into this digging business, which Mr. EATON refers to, about as carefully as any of my brothers who have spoken before me. But the method which I propose to give you is just on simple, plain cloths, twills, and sateens. In fancy goods we go into it more minutely, putting in the cost of everything, — twisting, combing, different grades of

cotton, amount of waste, and everything that goes to make up the cost. But we have tables by which we work out all these costs. And after we find what a class of goods costs, then we figure up the amount of profit we should get — not in these times, but generally — on that average number. Our tables show the profit we should make on a certain number of yarn; which is a certain percentage on our capital. When figuring cost we have about as much red tape, I think, as anybody, — fully as much as I like to have.

METHOD OF FIGURING THE COST OF COTTON GOODS.

By Mr. WILLIAM J. KENT, New Bedford, Mass.

In presenting to this Association our method of figuring cost of goods, I want it understood at the outset that we do not consider it perfect, but we are able by it to figure the cost of goods in a conservative way, and are also able to cope with our competitors.

When figuring the cost of plain, twill, or sateen goods, we first find the average number, then the yards per day the loom will produce, allowing a certain percentage for stoppage, then the pounds per day per loom.

COST OF LABOR.

Taking the average number we multiply by the cost per number; this result is the cost of all labor, except weaving.

COST OF SUPPLIES.

Taking the cost of supplies and multiplying it by six and dividing this result by the pounds a loom will produce per day, you have the cost per pound for supplies. The factor six, used in getting the cost of supplies, means six pounds per loom, our amount of cost being estimated at this production.

COST OF COTTON.

Taking the cost of cotton used and adding the percentage of waste made we have the cost of material used.

Cost of Weaving.

Take the pounds produced per loom per day and multiply by the number of looms run to a weaver, you have the pounds a weaver will produce. Divide the earnings you wish your weaver to make per day by the pounds produced, and you will have for a result the cost per pound for weaving.

Total Cost.

Adding the cost of labor, cost of supplies, cost of cotton, and cost of weaving together, you will have the cost of goods per pound. This result divided by the yards of cloth in a pound, gives the cost per yard.

The President. Does any member wish to ask Mr. Kent any questions? If not, his paper will conclude this topic.

We will now take up the subject, "The Cost of Steam per Horse-power per Year, where Mills are using plain condensing Engines." A report from a committee of the Board will be presented, giving facts upon the subject. Mr. Fred. C. McDuffie will present this subject.

Mr. McDuffie. In the absence of Mr. Thomas who was chairman of the committee, Mr. President, I will read the report which Mr. Thomas prepared for the committee. And before beginning the reading I will say that in the report is a table, and the figures contained in that table I have copied out here on the board so you might have them before you.

THE COST OF STEAM PER HORSE-POWER, PER YEAR, WHERE MILLS ARE USING PLAIN CONDENSING ENGINES.

To the President and Members of the N. E. Cotton Manufacturers Association:

GENTLEMEN, — The committee appointed from the Board of Government to obtain data as to the cost per horse-power per year, from various mills using plain condensing engines, beg leave to report as follows: —

Contrary to the expectations of the committee when appointed, much difficulty has been realized in obtaining sufficient practical data to prepare any elaborate or extensive table of costs.

We find many mills paying but very little attention to their cost of power. In many others, where the steam power is run in connection with water power, no exact data of the amount of steam power used are kept; and in a very considerable number, where the boilers are furnishing steam for many other purposes in connection with power, the separation of the amount is not kept. The mills from which the few figures given in the subjoined table were obtained, all have their special features; as will be seen by the notes following the table.

The figures asked for by the committee to be presented to you were for every day practice, and the report was designed to show the great stride made in the improvement of power plants as coal savers, and we trust a comparison of the annual cost per horse-power, with this type of engine, as compared with the costs that have been previously reported in communications to the Association, where compound or triple expansion engines have been and are used, will prove of ample interest to the members.

In the following table the first column represents the various mills alphabetically, from whom the data were obtained.

Annual Cost per Horse-power Developed from Plain Condensing Engines.

Mill.	Average horse-power for one year.	Cost per Horse-Power for One Year.				6 % Dep. & Int. on Cost of Buildings.	10% Dep. & Int. on Cost of Machinery.	Total Cost per horse-power. per year.
		Fuel.	Labor.	Oil & Supplies.	Repairs.			
A	1250	$12.06	$1.52	$0.16	$0.16	$0.60	$3.12	$17.62
B	600	19.50	3.01	.21	.02	1.19	4.68	28.61
C	917	12.61	3.67	.16	.16	1.77	7.50	25.77
D	1239	12.59	2.10	.17	.20	.56	3.23	18.85
E	770	15.49	2.74		.06			
F	1300	11.07	2.27	.12	.31	.74	3.38	17.89
G	1431	17.11	3.11	.23	.16	1.51	2.87	24.99
H	1055	15.82	3.25	.47	.22	1.65	3.97	25.38
I	865	14.14	3.06	.26	.04	.42	3.32	21.24
J	920	15.75	2.32	.15	.03		7.79	26.04

The second column, the average daily horse-power used for one year.

The third column, the cost of all fuel for one year per horse-power.

The fourth column, the cost of labor, viz., engineers, firemen, coal wheelers, oilers, etc., per horse-power for one year.

The fifth column, the cost of oil and supplies for one year per horse-power.

The sixth column, the cost of repairs per horse-power for one year.

The seventh column represents six per cent interest and depreciation on original cost of buildings used for steam plant divided by the average horse-power used for one year.

The eighth column represents ten per cent interest and depreciation on original cost of steam plant including engines, boilers, pumps, pipings, fittings, etc., divided by the average horse-power used for one year.

The last column represents the additions of the previous columns, excepting the first and second, and represents the total cost per horse-power per year.

MILL A. Using soft coal at $3.50 per ton, with pea and dust at $2.35 delivered. Horizontal tubular boilers. Engine of the Corliss type. This engine is run three fourths condensing.

MILL B. Using soft coal at $3.85 per short ton, delivered. Of the 600 horse-power, at which this plant is rated, 520 were developed by the engine, the remaining 80 from the water entrained and weighed, being the amount estimated as used by the slashers, etc., in direct steam.

MILL C. Coal at $4.12 per ton. Days in year, three hundred and nine. The engine is usually run three fourths condensing, in extremely cold weather half condensing. The exhaust steam is used for slashing, heating, etc. The cost per year, including these, is $41.92, but the amount paid for fuel

and labor for these purposes in a previous year, when they were separately provided for, being deducted, the result given in the table is reached.

MILL D. Bituminous coal at $4 per long ton, delivered. The coal given in the table included the value of exhaust steam used for heating feed-water, three slashers all the year round, and heating mill in winter. It is a Harris-Corliss engine run one half condensing. Horizontal boilers.

MILL E. Year of three hundred and one and one half working days. Burns anthracite coal at about $3.50 per long ton, delivered, under Harrison boilers. Above expense covers all fuel used. Engine runs three fourths condensing, using exhaust steam at not over one pound pressure for two slashers and heating feed-water. In winter for heating mill also. Boilers also furnish steam for size making and to some extent for heating on very cold days.

In the previous year cost for fuel was $14.93 per horsepower, and of labor $2.66.

Engine house not separate from mills. Engine and boilers cost $33,000. Cost of connections, etc., not known.

MILL F. Year of three hundred working days. Burns one half Pocahontas bituminous coal and one half anthracite screenings. Expense for labor includes night fireman. Exhaust steam used for three slashers and heating mill. Engine run three fourths condensing. Engine room a part of mill.

MILL G. Burns all bituminous coal. Same boilers supply heat for mills and steam for slashers. Cost for fuel in the table represents that used for power only. Engine condensing all ends.

MILL H. Burns bituminous coal. Same boilers supply heat for mill, vapor steam for weave rooms and supply small dyehouse. Engine condensing all ends. Fuel cost in table for power only.

MILL I. Figures given are obtained by doubling the expenses of a six-months run, Jan. 1 to July 1. Fuel, fifty-two and one half per cent bituminous, forty-seven and one half per cent pea and dust at $3.75 per long ton. The power given is developed by three engines, two small ones of fifteen and thirty-five horse-power running electric dynamos. Engineer has care of light plant; and charges for oil, supplies, labor, to this department are included in table. Direct steam used for heating and slashers. Engine all condensing.

MILL J. Engines a pair of plain condensing Corliss, built for seven hundred horse-power, at time taken were overloaded. The expense includes warming during winter months of 1,452,-906 cubic feet space in mill. Original cost of boilers very high by reason of certain tests of materials. Engine house a part of mill.

When running 600 horse-power, lbs. coal per hour per horse-power .	1.93
When running 920 horse-power, as in table, per hour per horse-power,	2.29
When running 700 horse-power, by subsequently compounding them .	1.65

Your committee tender their thanks to members of the Association and others who submitted their figures for comparison.

E. W. THOMAS,
FRED. C. MCDUFFIE,
WILLIAM J. KENT,
Committee.

Mr. WALTER E. PARKER. You did not name the average cost per ton for Mill F. Is it in the report?

Mr. McDUFFIE. I understand that all of the figures that were given were put into these explanatory notes, and that I have read to you everything that was furnished by the representative of the mill who sent his figures to the committee. I will look at Mill F again.

Mr. McDUFFIE then read the figures for Mill F.

The PRESIDENT. Do the members wish to ask any other questions?

Mr. EDWARD ATKINSON. It will be remembered that when the subject of smoke prevention was before the Association, a year or so ago, I subsequently prepared some questions carrying out the suggestion there made, that the manufacture of steam should be dealt with as a separate and distinct art from the operation of the engine or the cost per horse-power. You have all received very minute questions, to which very few answers were returned.

The general conclusion which I reached was this, that scarcely any attention has yet been given to the subject of the cost of steam, separated from the operation of the engine, and that you will not reach sound conclusions on any of these matters until these matters are separated. A good many persons did take a good deal of pains, and I have a number of replies; not enough to make any tabulation, either by myself or by Mr. GRAY and Mr. WOODBURY, who know the subject better than I do. But if this committee is continued, I think I may get the consent of every one who did make a return, to turn those papers over, so far as they go, for the further study of this important subject. I hope the committee will be continued; for the matter is one on which we are yet as in the alphabet.

Mr. WALTER E. PARKER. I am very glad, Mr [illegible] t, to hear Mr. ATKINSON'S suggestion. I have [illegible] elaborate report myself in answer to his questi[illegible]

never have sent it in. It is a matter which required a good deal of time and labor, and it has not been sent in simply because we had not reached it. But I shall be very glad to turn over my figures to the Board of Government, to be incorporated in this report, and I hope that the other mills will consent to Mr. ATKINSON's suggestion.

The PRESIDENT. If no one wishes to speak further on this subject, we will now take up the topic of "Mill Construction," which will be treated by Mr. EDWARD ATKINSON, of Boston.

MILL CONSTRUCTION.

By Mr. EDWARD ATKINSON, Boston, Mass.

FOUNDATIONS.

In presenting the subject of a self-sustaining mill frame, which I have sometimes called a project for the mill to hold up the wall rather than the wall to hold up the mill, I shall deal partly on the bases of my own experience, partly on that of others, and I may also present some theories based on this experience which have not yet been put into practice.

I suppose many of you have had to deal with foundations resting on different kinds of subsoils. In my drawing, PLATE 1, I have assumed a not unfrequent case; one end of the mill being over rock, the middle part over clay or hard pan, the end nearest the river over quicksand or other treacherous material. When a heavy and continuous foundation is laid under such conditions we all know that it is apt to settle differentially, to crack the walls and to throw the shafting out of line.

POSTS.

In the self-sustaining mill frame I therefore suggest that every post, including the outer line of posts to which the light wall is to be attached, shall each be supported on a pier exactly adapted to the conditions of the soil at that point. I include among these separate piers those under the outer line of posts although the outer wall will require a continuous foundation of its own. If that continuous foundation is kept entirely s rate from the piers under the outer line of posts it can b readily dealt with and more surely maintained on a tru

It seems to me wholly feasible that if the posts

adjusted, and there should thereafter happen to be a settlement of one or more piers not affecting others, — then any good mechanic may adjust some kind of a grip to the sides of that particular post, and lift it with jack screws with its section of floor again to a level, filling in underneath the posts upon the top of the pier. It seems to me that this would be a better method of levelling up than raising the beams from the posts, as is sometimes practised. I have planned to make the posts of square section chamfered at the corners, solid, or built up as the case may be.

Basement Floors.

I suppose you have almost all of you met the difficult question how to treat a decayed basement floor. We have reached the conclusion that there should be no unused hollow space under the lower floor of a mill. It is almost impossible to ventilate such a space. It is a resort for vermin; and the humidity generated in it almost surely causes decay in the timbers and in the floor. This space should be filled up with well-drained rubble or gravel, and should be concreted. This concrete should not be of cement, because cement is what the chemists call hygroscopic: it absorbs moisture, it rots timbers laid upon it, and it rots plank laid upon it. On the other hand, a concrete of asphalt or of coal tar is a non-heat-conductor, it is antiseptic, it preserves timber and plank, and it is warm under the feet. Nevertheless, when it becomes necessary to lay heavy timbers in such a concrete, the spaces between the timbers being filled up, they may become hermetically sealed and would, therefore, be liable to what is called dry rot; dry rot being the fermentation of the albumen in the pores of the timber. I should therefore always recommend the use of vulcanized timber, as it is called, which can now be had at a very small additional charge, — this timber having been subjected to a baking heat which hardens the albumen and stops the fermentation, and I believe that chestnut plank is better to be placed over the concrete than any other kind.

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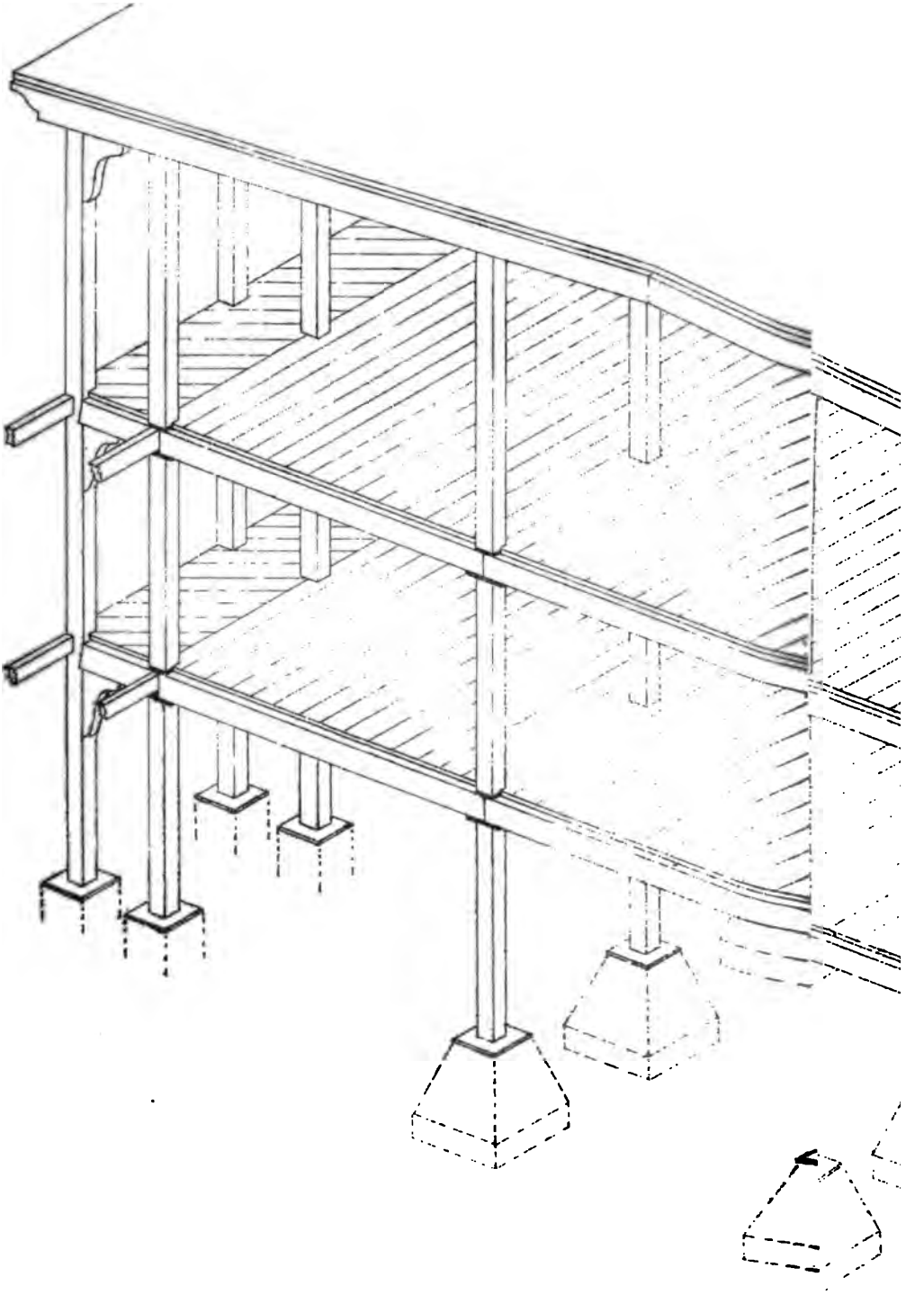
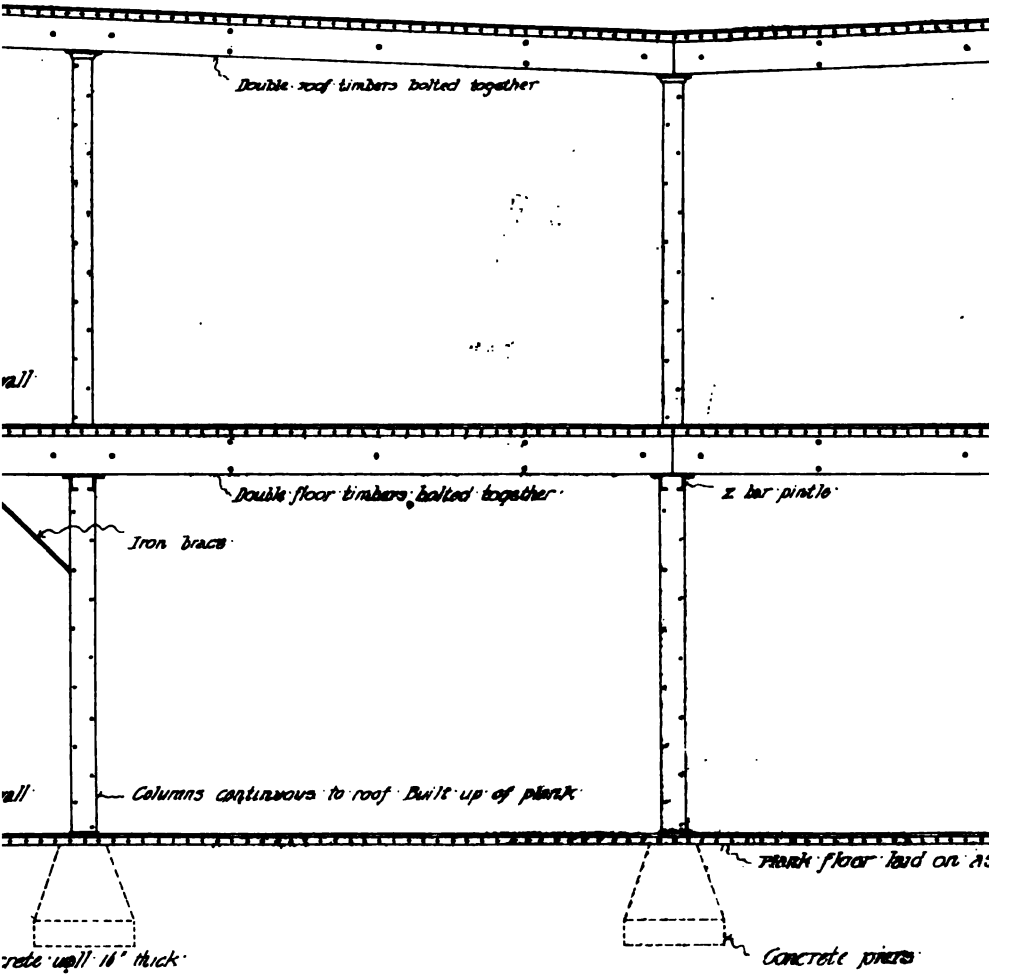
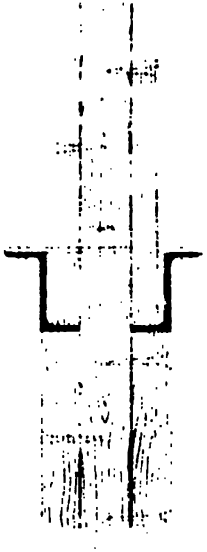



Double roof timbers bolted together
wall
Double floor timbers bolted together
z bar pintle
Iron braces
wall
Columns continuous to roof Built up of plank
Plank floor laid on
rete wall 18" thick
Concrete piers



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Frame.

In constructing the self-sustaining frame, I suggest building the corridor and alleyway, or series of alleyways, one over another, separately, of whatever width may be required for the alleyways. I have here a drawing of this part of the structure, Plate 1. You will observe that in the first place it gives a broad base; each element well fastened to all the rest, so as to bear the sideward stress or wind pressure upon the mill. These alleyways may be constructed so as to become, in effect, horizontal trusses, by laying the plank and the boards crosswise. These, being suitably braced underneath, will give absolute strength, and freedom from vibration, to this part of the structure to which the material of the outer wall is to be attached; and within which the machine-bearing floor is to be set up.

Machine-bearing Floor.

Within this corridor I propose to put up the machine-bearing floor in the usual way, each section resting on its respective post, each post on its own pier, so that any post may be destroyed or broken or burned, bringing down only that section without impairing the strength of the main frame.

I will repeat again, at this point, the oft-repeated caution not to paint heavy beams or posts without making careful provision for inside ventilation. They may be kalsomined or whitened with porous material; but I know from the bitter experience of myself and others, how certainly dry rot will ensue if green timber is painted with an impervious paint holding the moisture within.

Roof.

You will observe that the roof is drawn at a pitch of a half an inch to the foot inward, Plate 2. We have reached the conclusion developed by experience in many instances, that this is a better form of roof, for drainage and all other purposes, than

the ordinary roof pitched from the centre toward the side. The water is carried off in winter through inside ducts which do not freeze. The drip from the eaves is prevented, while the roof itself, if properly constructed with due regard to strength of timber substantially equal to that of the floor timbers, will bear any weight of snow that can possibly come upon it. We cannot conceive of a snow storm that would put upon a roof snow enough to make one foot of solid ice upon a level, and that would be a weight which every roof timber ought to be strong enough to bear without deflection. On the other hand, when this roof is pitched toward the centre the parapet wall gives a very much better architectural effect to the building. A mill may be of good proportion, admirable in its mass, excellent in the form of its towers, and yet a thin projecting cornice directly over the upper windows gives a weak effect which is not architecturally good. I think it is very desirable to secure good architectural effect whenever and wherever it can be gained, either by abetter form of structure, or by skill in design, without sacrificing any of the elements of useful and safe construction. I hope our professional architects may soon apply their energy to this class of buildings. At present with rare exception, it is not safe to employ them.

Roof Covering.

It is assumed that as a rule the roof covering will be the customary composition of tar and gravel. We have suggested cotton duck properly prepared and it has in more than one instance been put on with complete success and has proved to be lighter and more durable than the ordinary composition roof. But the right method of putting it on is not well comprehended; and if the work is not well done it will give great trouble. In my judgment, the true covering for an outside roof of low pitch has not yet been invented. I think it will yet be made out of wood pulp vulcanized or properly prepared.

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Towers.

You will observe in Plate 4 that we have placed the front towers at each corner. Of course the belt tower, elevator shaft, and water-closets will be placed in the rear, adjacent to the centre of the mill. We think the front towers better at the corners than in the middle. There is less obstruction to light, easier access each way, and a saving of the large open space which is usually left in the middle of the mill unoccupied with machinery, which open space we propose to put into a somewhat wider alleyway or corridor than is customary. In these circular towers it would be feasible to adopt Mr. Christopher Clarke's ingenious invention for giving a separate stairway to each room. This is not perhaps necessary in our factories where the number of people on each floor is not very great, but this invention is one which certainly ought to be considered in connection with school-houses and other public buildings. I have therefore requested Mr. Clarke to bring the models and drawings here, in the hope that you will incorporate in the report of this meeting a diagram and description of this useful invention. It is, of course, very desirable that each floor should be kept absolutely separate from every other with no openings either for belts or by stairways, and when you begin to run each shaft by an independent dynamo electric machine, in place of conveying the power by belts or ropes, this absolute separation will become practically feasible. It has long been my opinion that each main element in the shafting of a room should in some way be provided with an independent motor, to be stopped or started at will, and to be subject to changes in speed without great alteration in the other shafts or belts conveying power.

In this matter of separate floors you will bear
well-constructed floor of three-inch plank co
inch top boards, has never been burned th
in any working department of a mill withi
When the fires have spread from one roo

have gone through belt holes, elevator shafts or stairways. In one instance, a fire in a storehouse at the bottom of a pile of jute burned through, opening a way to the next room, through which the firemen sent a stream of water; the fire itself providing a way by which it was more easily extinguished.

In this connection I would call your attention to the fact that we do a great deal of what we call missionary business. The rules of slow burning or mill construction are being adopted all over the country. In some places, under recent building acts, the mill floor is made compulsory above a certain level. This is the case in Boston; but they have overdone it. In the new building act the factor of safety is so absurdly excessive as to require the use of an utterly wasteful amount of timber. It is vexatious to come across architects who, on the one side, fail in providing sufficient strength in the mill floor, and, on the other hand, must meet compulsory building acts which are at the very opposite extreme.

There are a great many large buildings in the West, in which mill construction has been adopted, and in one such building in St. Louis a very serious fire occurred. Mr. Geo. D. Markham, who lately addressed a meeting of the Sunflower Club, at Topeka, Kan., announcing himself as a "slow combustion crank," has given the following letter which I think is very important; being a bit of disinterested testimony on a matter to which I have given attention: —

St. Louis, Oct. 24, 1892.

Dear Sir, — Replying to your request, I beg to advise you that the estimated values of our stock, at the time of the fire of Sept. 10, were about as follows: —

On the sixth and seventh floors there were about fifty thousand dollars' worth of goods which were not damaged. On the fifth floor the value was about the same and there was a damage of about five thousand five hundred dollars, which was occasioned by a stream of water being thrown unnecessarily as there was no fire on this floor.

On the fourth floor (the floor upon which the fire originated), there was about eighty thousand dollars in value, on which the damage was a little over forty thousand dollars.

On the third floor the value of the stock was about one hundred and fifteen thousand dollars on which the damage was about three thousand five hundred dollars.

On the second floor the value was about one hundred and fifteen thousand dollars, and the damage was about seven hundred and eighty dollars.

In the cellar there were goods stored to the amount of ninety thousand dollars, and upon which the damage was less than fifty dollars.

A vast quantity of water was thrown upon the fourth floor, and the water when the fire was extinguished was about two or three inches deep. There must have been from fifteen to eighteen streams playing upon the fire upon this floor.

We are very much pleased that the damage upon the floors other than that upon which the fire originated should be so small, and consider that we have to thank the construction of the building that the loss was so small.

Yours very truly,

A. F. SHAPLEIGH, *Secretary.*

WINDOWS.

We recommend the double-glazed, mullion window — the lower members fixed, the transom opening inward for ventilation. It has been said that double glazing does not keep clear within the space between the plates. This I attribute wholly to bad glazing. Whenever the glass has been well set in clean condition double glazing is a complete success. Such a window keeps out heat and cold, it does not become coated with frost and it enables you to regulate the atmosphere within better than it can be done in any other way. I recommend double glazed window with solid sash well set in the

This window will outlast the ordinary ramshackle window with its pulley stiles and boxes, glazed with thin glass. I recommend again the outer pane of glass to be ribbed. I have dealt with this subject before. I again present to you evidence that the fine ribbed glass — twenty-one or twenty-two ribs to the inch with true curves — will diffuse the light throughout your weaving and spinning rooms in a way that you can little comprehend unless you have witnessed it. It costs but a trifle more than the plain glass and it will save you from the need of putting up window shades. But even when ribbed glass is used on a strictly southern aspect where the glare of the sun is constant, I think it may be desirable to use a green tinted glass in order to obstruct a part of the light. You will even then have more effective light in the room than you do from clear glass with the window shade let down, or from clear glass clouded in any way and you still retain the benefit of the wide diffusion of the light. This diffusion does away mainly with shadows on the loom or on the machinery.

I have here the photographs of varieties of glass and a plate giving the diffusion from the kind that we have chosen as the clearest and best.

Walls.

You will remark that we have dealt with every part of the mill except that part of the wall which does not consist of windows. It has often been held that the inertia of a heavy wall is necessary to overcome vibration and to bear the sideway pressure of wind; but you will remark that even the heaviest wall has a very narrow base in proportion to its height, and in my judgment the self-sustaining frame veneered with a light wall will be vastly more stable and free from vibration than any heavy wall that can be contemplated. Moreover in modern practice you want at least six feet of glass to every four feet of window frame and wall; and in the structure which I now recommend you have merely a series of brick pilasters breaking up the flat lines of the wall; giving variety and architectural

Boston Manufacturers Mutual Fire Insurance Co.

No. 50.

DIFFUSION OF LIGHT.

A plate of clear, double-thick German glass, one-eighth inch in thickness, such as is customarily used in glazing factory windows, obstructs light from an Argand gas burner about eight per cent. Light passes through such clear glass without diffusion, making an image corresponding to the somewhat crude impression given in plate No. 1, when the light is put through an aperture of about the same size as the image We have been unable to get a direct transfer from the photograph, and this impression has been engraved on wood. The light is, of course, intense where it strikes, making deep shadows, but it is not diffused.

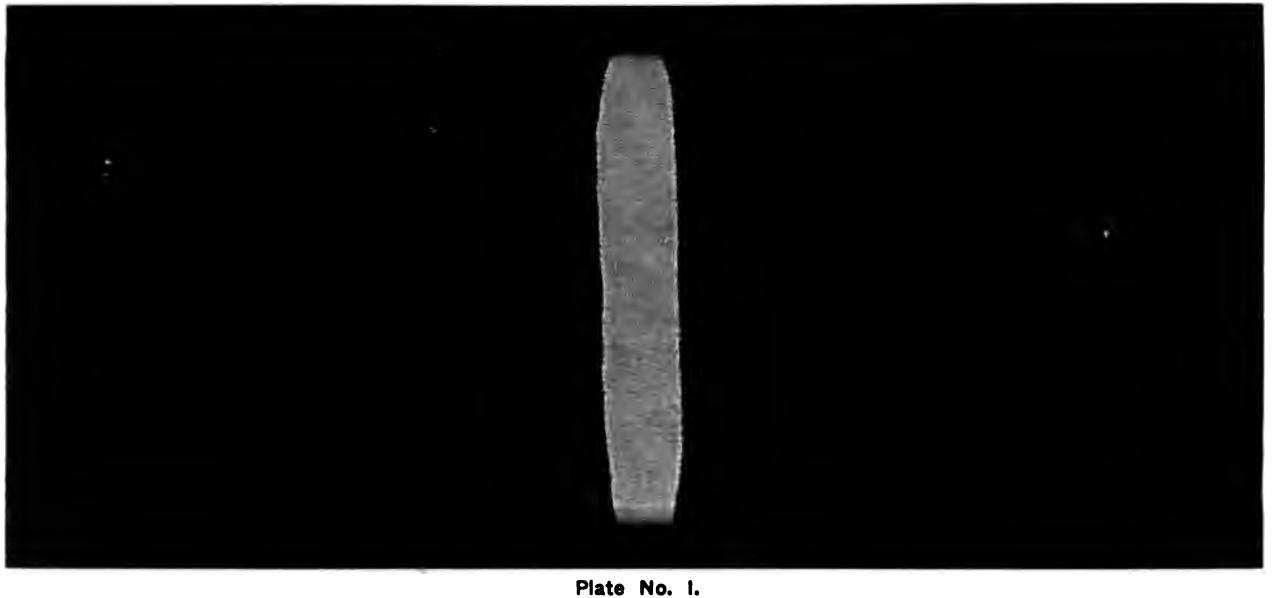

Plate No. 1.

The same light, passed under similar conditions through a plate of fine ribbed glass one-eighth inch in thickness, is diffused sixty-nine to seventy degrees, and there is no greater obstruction or loss in transmission than through the clear glass. This diffused light is not intense at any point, and heavy shadows are therefore avoided. The image given by the photograph has been copied as well as it might be in plate No. 2.

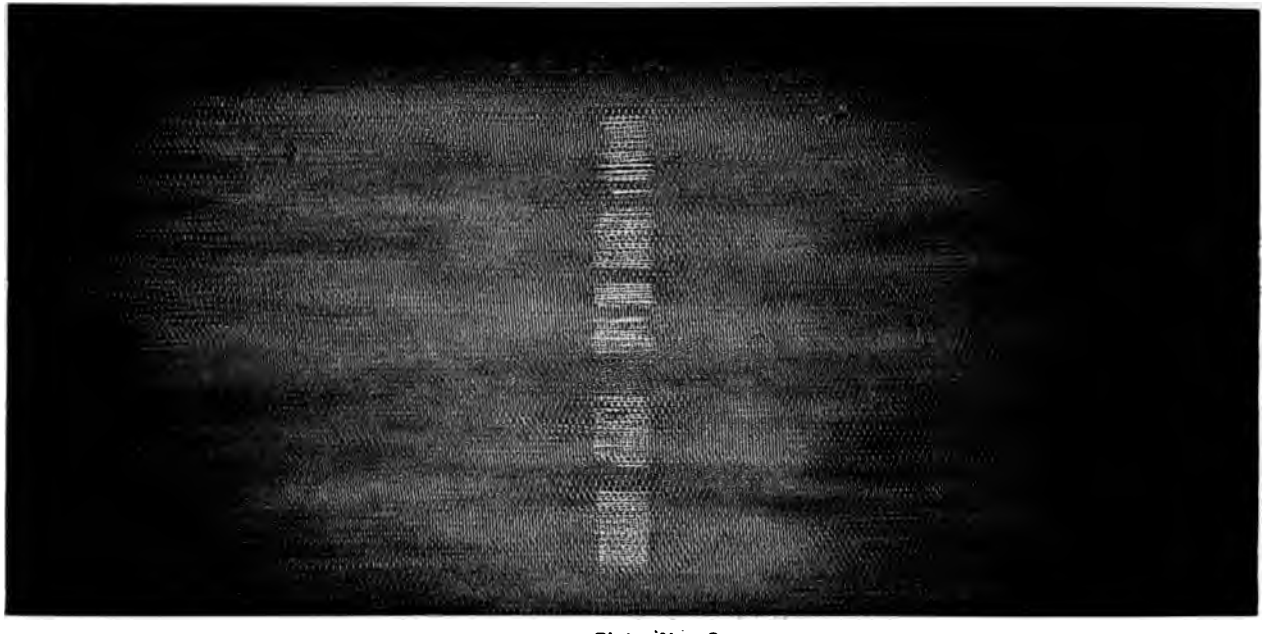

Plate No. 2.

This one-eighth inch ribbed glass, from which this impression was taken, will be known as "Factory Glass." It is sold by Hills, Turner & Company, 193 State Street, Boston. This type, which we have named "Factory Glass," is a very pure crystal white. It is possible that on the south side of a building even this kind of ribbed glass may be too clear, and, although the light may be diffused very adequately through the room, it may be yet a little too bright near the window.

There are several varieties of fine ribbed glass of a greenish tinge. The more green it is, the more the intensity or glare of the light will be overcome, while the diffusion will be equally well assured. It may therefore be expedient, under some circumstances, to try both kinds before deciding which to use, so as to be certain to avoid the need of window shades. The greenish glass will obstruct the light a little more than the pure crystal glass, and may be used without window shades. It may therefore give a more effective illumination than clear, plain glass or the crystal ribbed glass when either is screened with window shades. On any exposure but the southern, the crystal ribbed glass may probably be used without window shades.

In glazing with ribbed glass, the smooth side should be outward, the ribs inward.

EDWARD ATKINSON, *President.*

FEBRUARY, 1893.

effect, and enclosing on three sides the end posts of the self sustaining frame. Of course these pilasters with curtains between them, under the windows, must have some support; and must therefore be placed upon a light continuous foundation, which should be wholly separate and detached from the piers on which the outer posts are sustained.

The question may arise what kind of brick to use. There is as yet no science of brick. There is little or no knowledge of the relative properties of brick in respect to the absorption of moisture and the conduction of heat and cold. Brick vary greatly in these respects. Many kinds of modern brick, commonly called "fancy brick" with which you are familiar, are vastly better than the common brick customarily used in factory construction both in respect to absorbing moisture and the passage of heat and cold. Each kind can be tested on its own merits at very little cost. These fancy brick are more expensive, but on the other hand the quantity required in such a wall as I propose would be very much less in number than is required in the ordinary method of construction. I am glad to say that an expert working in the Harvard Scientific School, under the direction of Prof. Shaler, is making exhaustive experiments in regard to brick, mortar, and cement, and we shall ere long be in possession of scientific and accurate knowledge on these important subjects of which we yet really know so little.

I may startle you a bit when I say that if I were myself building a two-story mill or even a three-story mill I would build it exclusively of timber, plank, and glass, provided it were isolated and free from the ordinary restrictions of the building acts of cities. A thick wall of plank with double-glazed windows on a self-sustaining frame would, in my judgment, be warmer in winter, cooler in summer and better in every way than the ordinary brick wall. It could be lined up on the inside, not only over the face of the timber and the posts, but over the face of the inside of the wooden window frames, with plaster board of the kind of which I now show you an example,

which is being introduced into the market; known as the Sackett Wall Board. This can be nailed up anywhere smoothly, and well jointed. It can then be painted or kalsomined or a skim coat of hard plaster can be laid directly upon it. My own judgment is that such a mill of timber, double glazed windows, plank and plaster wall board would be one in which you might attain absolute control over temperature and humidity in the most effective manner. Your brick wall with single windows when exposed to cold winds is a condenser of moisture; within, your walls and windows drip with humidity withdrawn from the atmosphere, and then your work runs as badly as it can.

Built up Timbers.

I now call your attention to a type of frame, novel in some respects, which has been devised by my son, Mr. William Atkinson, who made these drawings. The essential element in this design consists in the absolute separation of the wall from the frame. A thin curtain wall, bearing nothing but its own weight, rests on a separate foundation of its own. For its lateral stability, this wall depends upon the timber frame of the mill being secured to the ends of the floor beams at its "panel points" (to adopt an engineering term). The wall being reduced to a mere weather guard, a great saving of brick is thus effected. The frame is designed to be stiff enough in itself to resist all cross stresses and vibrations. This stiffness is obtained by the use of continuous columns and a wrought-iron pintle of special design. As an extra precaution, iron angle braces are also shown. (See Plates 2 and 3.) The built-up, continuous column was first brought to my notice by Mr. S. E. Loring, architect, of Syracuse, N. Y. It will not be long before it will be difficult and costly to get heavy timbers, even of hard pine. These *built-up timbers* of plank may be made of kinds of wood which would otherwise not be considered very suitable for use, — even hard pine twists sometimes, — but

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if the direction of every other plank be reversed, the twist of one may be counterbalanced by the twist of the other, and may retain stable conditions; while the cracks between the plank will serve for ventilation, with absolute assurance against dry rot. I think that such a frame as this, stiffened and braced at the joints, braced at every point and well put together, would make a vastly better mill than any of the mills that are constructed even on the so-called fire-proof principle, with metal beams and concrete floors. I am of the opinion that a timber and plank mill will be less subject to vibration than any mill that can be built of brick, with iron beams.

I know one instance where a very expensive woolen mill was constructed on the fireproof plan, and the machinery was placed directly upon its solid floor. It was subject to such vibration by the contact of metal frame with metal beam, that it could not be operated successfully. The owner sent to New England for a Yankee manager who immediately covered every floor with plank and placed the machinery on this, and thus by cutting off the vibrations he was enabled to operate the machinery at the customary speed.

I long since suggested that in building spinning frames blocks of wood should be put in here and there in the frame to cut off the metallic vibrations. For the same reason I believe that the elasticity of the wood itself, subject as it is to a different law of vibration from that of the metal, makes wood a better bearing for machinery than anything else can be.

I have with me the plates which belong with the missionary documents of the Boston Manufacturers Mutual Fire Insurance Company, which substantially coincide with the plans which I have presented to you. These plates and their description can be incorporated in the report of this meeting.

It may startle you to have the president of an insurance company commend a timber and plank structure. You will bear in mind that brick walls are no safeguard against an outside hazard when there are six feet of glass to every four feet of brick. The hazard of a mill or workshop is within. This

is so well guarded against on the slow burning principle of construction, and by the introduction of sprinklers and other safeguards, as to have made our American type of mill less hazardous and less liable to complete destruction than the fire-proof mills, so-called, of Europe. This method of construction is, of course, very much less expensive. When a destructive fire does occur within brick walls there is seldom much salvage in the walls. My impression is that the timber frame, constructed on the lines which I have laid down to-day, will stand longer than the ordinary brick wall. I should, therefore, build, myself, of timber and glass; with a view to the complete control of the atmospheric conditions within, to stability, freedom from vibration, and effective service.

Art and Industry.

I have spoken of the expediency, I might say necessity, of giving more attention to the architectural effect and to the æsthetic appearance of our factories, and yet more of the dwelling places and of the surroundings of the factories. I have here a rather bad photograph of the new mill of the Cabot Manufacturing Company, at Brunswick, built with very low parapeted wall, and the slope of the roof toward the centre. I have not seen it myself, but it impresses every one who has seen it as extremely good in its effect.

I also have photographs of some of the best English and French factories, which are better in many respects in their effect than most of ours. This matter may not be essential in the plain, every-day spinning mill, but bear in mind that the carding and spinning mill may be the school from which weavers and finishers emerge. What can you expect of appreciation or development in the style of your goods, and in their adaptation to a growing and better taste in the community, if the working people in your factories, weave sheds, and print works get no color or variation in a monotonous and somewhat arduous life. The very atmosphere of France is permeated with an artistic sense, in which the working people share. It is

exhibited in the structure of their buildings and in their contents. Within the last few years your English competitors have learned this secret; and in almost every manufacturing town there is an art institute and an art school. Even in the technical and trade schools of Bradford, of Keighley, of Huddersfield and of Manchester, the artistic side is developed with the same care that the technical is treated.

The rule holds throughout both the higher instruction and the lower. The young man of first-rate ability will secure a better development, a broader education, and will be better able to adapt what he has learned in purely technical work, who enjoys the training of the university; and in the long run he will lead the man of the same capacity who has had the merely technical training of the technical school, unless the latter knows how to continue his education on his own behalf. The most practical work that can be done is to develop the higher education, including the artistic sense, no matter how prosaic and practical the occupation of the man may be in later life; as it is in the higher branches of instruction, so is it to the very base.

I believe, therefore, that it is essential to our ultimate success in developing the high grades of textile industry in this country that attention should be given to every phase of art, and especially to the development of factory buildings, workshops, warehouses, dwelling places, and especially in the surroundings, so that we may gradually evercome the bald, bare, dreary, and monotonous aspect of most of our factory towns and cities.

A greater contrast could not have been invented, purposely illustrating what I wish to impress upon you, than the methods of display of the foreign and domestic textile fabrics in the Chicago Exhibition. The French exhibit in the gallery
great building devoted to manufactures is wonderf
in respect to the fabrics exhibited, but in the ma
they were shown. The whole arrangement is art
and harmonious, excellent in detail, and yet n
the concrete.

Again, witness the wonderful German exhibit on the main floor, of iron work; and therein you find another example of the combination of art with industry. Pass along a little further on the main floor to the textiles of the United States; a collection, mostly, of tasteless, monotonous black coffins, in which good and useful fabrics were almost buried out of sight; nicknamed the "Undertakers' Alley," — such a blot in the centre of the great area that in very shame an additional contribution was made, to put a rather tawdry screen to hide these tasteless black cases from the general view of those who passed along the centre alleyway.

I think we shall never attain a high place in originating textile fabrics to meet the growing demand for something more than mere utility until the minds of all who are engaged in the work are pervaded with the necessity for developing the æsthetic and artistic sense, not only in the fabrics but in all the surroundings and in the structures in which the work is done.

I have made myself a thorn in the side of the American architects in my endeavor to force them to give attention to industrial problems. I now put myself in the position of a counter-irritant in dealing with you who are practical men. Until the architect and mill engineer can be brought together on a common motive, both art and industry will suffer.

Let me return, a moment, to the practical.

It will be observed that the construction of the self-sustaining frame can be fully accomplished without adopting the suggestion of an outside alleyway running between two lines of posts, outside the machine floor. One outer line of posts may be set within pilasters in the outer wall, so that the inside of each outer post will be flush with the wall or the window frame, and that post may be braced or tied to the first section of floor timbers with hackmatack knees or iron braces, so as to gain the full present measure of stability, without the extra line of posts, four or five feet distant from the wall, on the inside of a proposed alleyway. On the other hand, a very strong

brace may be given to a mill by constructing lengthwise, from one end of the mill to the other, and also crosswise from front to rear, a double line of posts, at such distance apart as may be devoted to these middle alleyways. These being braced and stiffened by floors for the alleys laid herring-bone fashion, will give the same stability that the outer corridor would give, only in a little different way.

This suggestion was made by one of the members of the Association after the meeting, who remarked that open spaces, not to be occupied by machinery, were better in the centre, at the point of least light, than on the sides; where it may be desirable to bring the machinery as near the windows as circumstances will permit. This is an important suggestion.

My purpose in submitting this description of an ideal mill may not result in the construction of a single building corresponding in every way to these suggestions, but I had another object in view. I witness, through the reports of our inspectors, faults in many mills even of very recent construction, which might have been avoided without increase of cost. They do not affect the fire risk, but they may affect the economy of the work by bringing on extra repairs at a very early date; as, for instance, in the decay of timbers by premature painting, and in the decay of basement floors where the space ought to have been filled up. When these points are brought to my attention in the regular course of my business, it would be officious for me to remark upon them when they are presented to me, because they do not affect the fire risk.

In submitting my ideal plan, I have, therefore, dealt with every fault that has lately come to my notice, in which I think a more careful consideration of all the points of construction might have led to better results. If the members will apply each element of the ideal mill to that particular element in th construction of their own mills, they may be convinced th even the theorist who, of necessity, looks over the whole fie may have given some valuable hints by which every practi man may avoid a particular error. Doubtless if each mem

of the Association would take up my ideal plan (as I wish they would, and amend it), then out of the mass of suggestions combined, the true mill might be evolved from the germ which I have attempted to present to you in this treatise.

Mr. HENRY F. LIPPITT. Before Mr. ATKINSON sits down, I think it is only fair to suggest that these coffin-like cases which he finds fault with contained exclusively the exhibit of the woolen manufacturers, and not that of the cotton manufacturers. We are willing to take care of all the sins of actual commission that are put upon us, but we do not want to have to be responsible for those of other people.

Mr. ATKINSON. I am sorry to say I observed in some of the front lines of cases, in some of the objectionable ones, a great many cotton fabrics that did not have much of a show.

Mr. LIPPITT. I think if Mr. ATKINSON will go through the exhibit of the cotton people, he will find the cases are of great diversity, scarcely any two alike; and while there may have been one or two black, I did not consider that black was a color which, in proper distribution, was not a good one to use. I think what every one objected to was the uniformly black cases of the woolen exhibit. The woolen exhibit was all superintended by one man. The cases were all made of uniform height and color and were uniform in every way. The cases of the cotton exhibit were gotten up as each one's fancy dictated, and made a much better looking exhibit. And in fact we consider that the Manville Company's case at the Fair was on a par with any exhibit that was there, whether foreign or domestic.

Mr. ATKINSON. I take back so much as I am obliged to. But the general impression of the whole thing was so oppressive and unpleasant to my mind that after I had taken one glance I kept clear of it; and so did most of the people. There may have been exceptions, but the general impression was that the textile exhibit was bald, inartistic and dreary; subject to the exceptional merits of the Manville Company's exhibit and one or two others.

Mr. CLARKE has a model and drawings of his stairway, which will be open to your inspection after the meeting dissolves. I did not have time to communicate with the officers, but as I wanted to illustrate a round tower, I thought I might ask Mr. CLARKE to come here so that those who, after the meeting, would like to look at his designs, would be able to do so.

Mr. WALTER E. PARKER. May I say a word just now? Mr. CLARKE has been spoken of, and it has been suggested that he show the members what he has for a stairway, after the meeting. I think all the members could see what he has better in open meeting, and I would make a motion that he be allowed to show what he has, now.

(The motion was seconded and carried.)

The PRESIDENT. I would say that Mr. WEEKS has prepared a paper on "Mill Heating," and if the members would like to hear it, he would no doubt he glad to deliver it.

Mr. WEEKS. I would simply say I was notified by telephone yesterday afternoon that I might be called upon to give a description of a heating plant placed in one of our mills two years ago. I have written a short description of it; but on account of a very bad cold I shall ask the privilege of having it read by Mr. WOODBURY, and any questions you may like to ask further in regard to it, I shall be happy to answer.

MILL HEATING.

By Mr. George W. Weeks, Clinton, Mass.

In the summer of 1891, The Lancaster Mills erected a building about 116 x 109 x 74 feet in height, divided into a basement of ten feet and four stories of about sixteen feet each in height.

The basement is used as a cloth inspecting room and for drawing in, etc. . The first, second, and third floors for weaving, and the fourth for quilling, beaming, and dressing.

The walls are a trifle over sixty per cent window openings and no outside or double windows have been used. It was proposed to heat this building by the blower and hot air system and the usual air flues were built in the walls and basement for this purpose; but after consulting with Mr. H. S. Robinson (now Vice-President of The Atlantic Works at East Boston) it was decided to put in on trial his system of heating air by means of water from the hot well of engine and add thereto a small engine and blower for use nights and Sundays when the large engine was not running. This plant has now been in use for two years and has proved to be in every way satisfactory and economical. The heat is obtained from the water discharged from the hot well of the compound engine driving the machinery in the building and the air is forced through the heater and flues by the fly wheel.

The ordinary Corliss fly wheel would force sufficient air for this purpose without alteration (we find the air pressure in one of our Corliss wheel pits to be equal to one and one half inches of water), but the wheel of the Wright Engine used in the mill being made with arms so shaped as to pass through the air with the least resistance, we found it necessary to add

DESCRIPTION OF DRAWINGS.

The same letters refer to the same things on plans and elevations.

A. Fly-wheel of engine cased in, as shown, with a circular opening near the shaft.
B. Air duct for collecting air, from the rim of the wheel, commencing small near the top of the wheel and gradually enlarging to the floor line.
C. Entrance of air to heater.
D. Outlet of air from heater.
E. Contraction of flue of duct on the way to the mill (12½ square feet).
F. Air duct from fan blower, when in operation.
G. Fan engine.
H. Fan blower.
I. Discharge pipe from hot well.
J. Overflow pipe for water, after passing through the heater, brought up nearly to the level of I, to insure the heaters being kept full of water.

I have not shown any of the running parts of the engine, which is a tandem compound, using steam from a horizontal tubular boiler, at 125 pounds pressure.

The heater shown on sheet No. 1 has eight sections, the water coming into the bottom of the first section and going out at the top.

Sheet No. 2 shows the details of the heater. The parts marked Nos. 3 and 4 show the construction. Each section is 42 inches high, 28 inches wide and 90 inches length of pipes.

Each one contains 204 one-half inch pipes. These pipes are screwed into the plate K, which is of steel one-quarter inch thick, and fastened to the plate L, of the same thickness, by nuts on each side of the plate. The flanged cast-iron cap M, which is fastened to

the plate K by bolts, has a wing which extends near enough to the plate K to make a reasonably tight joint, dividing this space into two equal parts. It has also two six-inch outlets, one in each division. This wing is marked N.

The cap O is made the same as N, except that it has no wing and no outlets. P shows a narrow plate bolted to the edges of plates K and L, making, with them, continuous side walls for the duct. R is a thin plate fastened to the top edges of plates K and L, making the top of the duct.

At No. 5 on sheet No. 2 two of these sections of heater are shown. They are marked S and T.

It will be seen readily that the water coming in through the pipe I fills the cap M to the wing N, and flows through the 102 pipes below that wing to the other end; and as there is no wing in cap O and no outlet, it fills that cap and flows back through the upper pipes to the top of cap M, and then through the pipe I through the top half section T to the cap at the other end, and down through the cap at that end and back through the lower half of pipes to the cap M in section T, and out through the outlet I.

All of the heaters are precisely alike, and the water finds its way to the final outlet at J, as shown on sheet No. 1, all of the sections being filled with water, as enough has come to fill them, and the water flowing away after this as fast as it comes from the hot well.

Air cocks are put on the top of cap O to let out the air while filling.

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"wings" to them. This wheel is sixteen feet in diameter and runs at a belt speed of four thousand feet per minute. After the wings were attached, we obtained a movement of eight thousand cubic feet of air per minute through the flues and mill with an expenditure of three horse-power as shown by the indicator.

The air is taken mostly from the basement where it enters from out of doors and largely from the connecting boiler house.

The heater is situated in the air duct leading to the flue, and consists of eight sections, each forty-two inches high by twenty-eight inches wide, with two hundred and four half-inch pipes, each ninety inches long. These sections are connected by pipe with the hot well, and so arranged that the end covers and diaphragm causes the hot water to flow by gravity through half of the pipes in one direction and return through the other half, and then continue through the other sections in the same manner, and discharging where the air enters; so that the air is always coming in contact with hotter water.

Small pipes were used in order to obtain the largest amount of heating surface in a given space, but as we find we have more heating surface than is needed, it would have been better perhaps to have used larger and fewer pipes so as to offer less resistance to the passage of the air.

The water from the hot well has usually a temperature of about 106° F., but we have found by testing several of our condensing engines that we could take this water at 116° without affecting the vacuum shown on the indicator cards. In fact no difference was shown on the cards with the hot well at 78° to 116°, though the gauge showed from 25½″ to 28″.

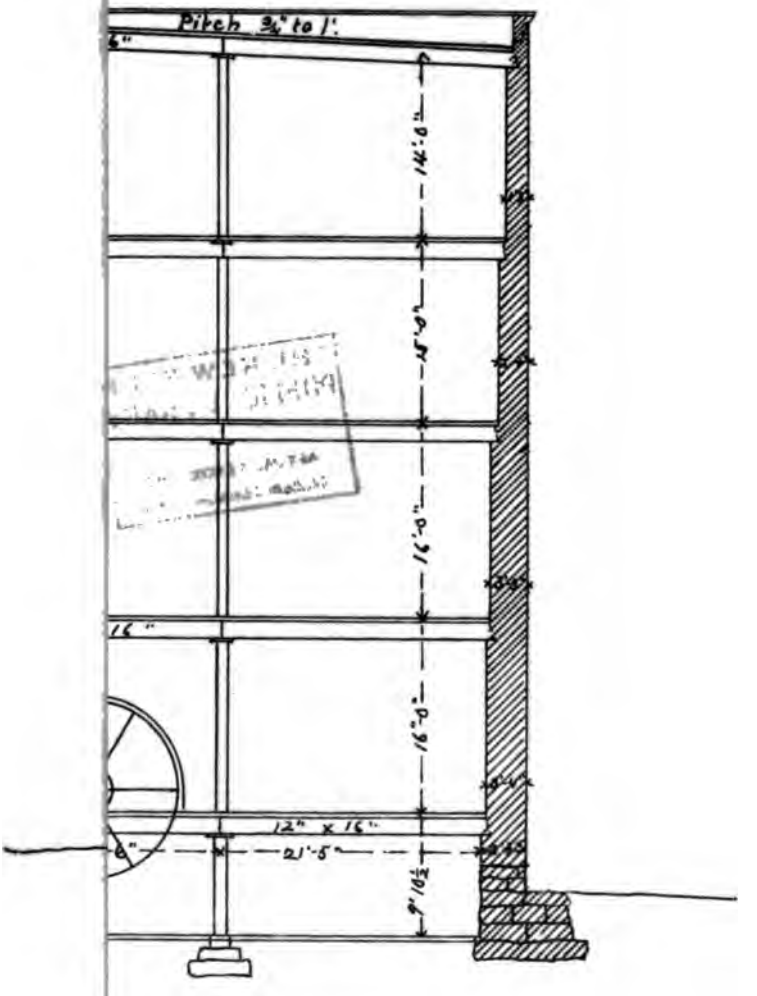
With water from hot well at 115° F. we heat the air to 100° F. In one test, air was taken directly from out of doors at a temperature of 26° and sent to the mill at 107°, with water taken from hot well at 123¼° and discharged from heater at 97½°. We find in practice that the air is heated to within about 10° of the water used. As stated before we put in a small

engine, fan, and blower to heat the mill before the large engine was started and to heat it also nights and Sundays during the winter; it would have been cheaper to have put in steam pipes in the old way, and if one does not object to pipes, the expense of the extra engine and blower may be saved.

While heating the mill in December, before the large engine was started, we ran the fan engine; exhausting the steam in the same heater. After the large engine started we drove the fan by belt from this engine using hot water from condenser of the heater, and while the walls were still wet, the mill having just been completed, with only a few looms in operation, we forced twelve thousand feet of air per minute into it, this being sufficient to heat it while in that condition. This required 8.81 horse-power as shown by indicator on engine. As soon as the "wings" were put on the arms of the fly wheel we started the air from that, and, as stated before, we heated the mill with eight thousand cubic feet of air per minute, as the looms were nearly all then in operation, and we found that to be sufficient. It took three horse-power only to furnish this air from the fly wheel.

We did not rig up to run the "blower" at a speed to force eight thousand feet per minute, but judging what it would take from the twelve thousand feet, it would doubtless require 5¾ horse-power to force eight thousand feet, or nearly double that required by the fly wheel.

Mr. Robinson suggested the use of the vapor on its way from the cylinder to the condenser, to add any heat needed to the air after passing the water heater, but did not use it, as the temperature at this point is only about 134°, while the weight of water in this vapor is very small as compared to the weight of water in the hot well, and this heater being a part of the condensing apparatus would have to be absolutely tight, and as a consequence be rather costly. So as we did not use the vapor, he put in a supplementary heater made exactly like the water heater, and placed in the air duct between the water heater and the mill, taking the steam from the receiver between



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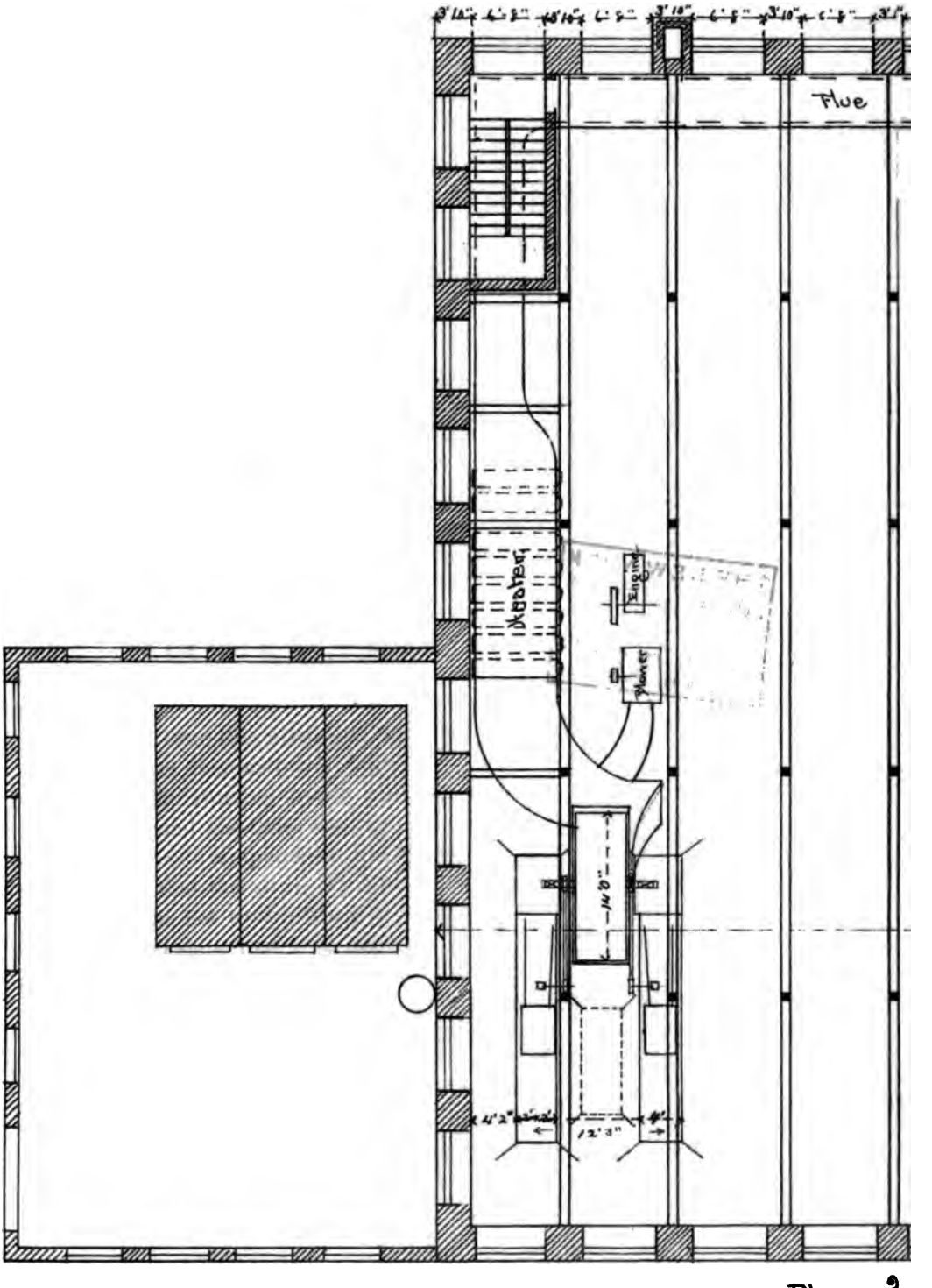

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the two cylinders of the compound engine to heat it. This heater also takes the exhaust steam from the fan engine nights and Sundays. It was found in practice that no steam was required in this heater while the mill was in operation, except in extremely cold weather, and I think last winter none at all was used in it.

We find that it requires about double the heating surface to heat with water that it does to heat with steam, but as water heaters have to sustain no pressure they can be furnished (as shown by drawings) for a very little more than steam heaters made in the usual way.

Hot or cold water can be showered into the duct in the usual way when desired. When the weather becomes warm enough, so that no heat is required in the mill, the water from the condenser is turned off, and the engine fly-wheel continues to force the same amount of air through it for ventilating and cooling; and for this latter purpose we can turn cold water through the pipes in the same manner as water from the hot well.

During the time this plant has been used, it has required no repairs and has demonstrated that it will heat and ventilate the mill during the running hours with *no* expenditure for steam or power beyond the three horse-power added to the engine as stated; that 100° temperature is sufficient to satisfactorily heat the mill, and that the air can be heated to this temperature, with water from the hot well with no loss of power, and our experiments tend to show that it is more economical (when the uptakes are built into the walls) to send a larger amount of air at a lower rather than a smaller amount at a higher temperature. Air heated to $97\frac{7}{10}$° at heater is delivered to the fourth story at $94\frac{1}{2}$°, showing a loss of only $3\frac{2}{10}$°, while air at 124° at heater was delivered at fourth story at only 113 showing a loss of 11°.

I would add that the use of the fly wheel as a fan, water from the hot well, and vapor from engine cylinders for heating purposes, and the plant as described, have been patented by Mr. Robinson.

Much of the steam used to run the small blower engine, immediately after shutting down at night, and before starting up in the morning, is obtained without extra cost, as considerable of this would otherwise be blown off from the boilers at these times.

Mr. WEEKS. The main point I wish to emphasize is the fact that we heat the mill with absolutely no expenditure for steam while the mill is running, with the single exception of the three horse-power caused by the wings of the engine wheel. But on an ordinary Corliss wheel, which presents a squarer surface to the air, there would be required no addition to the wheel whatever, and there would be no expense.

Mr. WOODBURY. I would like to ask Mr. WEEKS in regard to the remarkable statement, that there was no difference shown on indicator cards corresponding to differences at the hot well, although the vacuum gauges showed from twenty-five and one half inches to twenty-eight; whether there was more than one indicator that gave that uniform result; or whether the indicators had been thoroughly tested?

Mr. WEEKS. We had several indicators, and made these tests on several different engines. I referred particularly to tests made on a Corliss engine where the air pump was driven directly from the engine. In that case, they found no difference whatever in the cards, where the temperature of the water in the hot well ranged from seventy-eight to one hundred and sixty, although the gauge did show a difference. But none was shown in the cylinder.

Mr. CLARKE. I would say in the beginning that I shall be exceedingly brief. I have come from Northampton, one hundred and fifteen miles, to show you a system of towers to be attached, not only to factories, but to all public buildings; and which is especially valuable to factories in the preservation, not only of the factory itself, but of the people who work in it.

The compartment style is undoubtedly the one that is to come into use before long. It is adopted abroad; and in London only three thousand cubic feet are allowed in one room before a division wall is put in. Mr. Atkinson has spoken this morning in regard to using plank partitions for division or partition walls. They can be perfectly well applied to this system. For instance, you take the mill that is represented on the wall and divide it into three sections; the shafting running through the partition walls, so as not to interfere with its running, but in case of fire instantly protected, and the compartment on fire isolated from the rest of the buildings. Now, that being accomplished, we build the towers in such a position as is considered best according to the architecture of the building and the ground. Of course, in some factories it would have to be located at a very different point from others, but where there is plenty of ground room near the building you can locate it where it is the most desirable.

Another advantage of the tower is that it holds up the walls from falling in or out after the timbers are burned; and of course saves an immense damage to machinery which the falling walls cause. The tower is built of brick, and would be on an average about ten feet in diameter, with an entrance from each floor. Now, as far as insurance is concerned, the advantage of the tower and compartment plan is this: By making the floors slow-burning, according to Mr. ATKINSON's plan, and having the vestibule, or entrance to the tower, fire-proof, either by plank or brick or any other reliable method, the water that is poured into the burning compartment runs from the room, by means of a little decline from the floor to the entrance to the tower, and goes down the staircase to the ground; instead of damaging valuable machinery and goods that may be stored in the storehouse or in the factory itself. At the entrance you will see that little partition that is built from the ceiling to the landing, and that goes up to a steel ceiling on
of the tower. I will show you the steps. The ore
of the steps will be three feet; but where a

is constructed you can make them of unlimited size; three feet, however, would be the ordinary length of the steps. The people come on to the stairway landing, at each floor, and go directly to the ground. There is, usually, no communication whatever between the staircase that starts at a landing, and the one that is below it. They are built by ringing the steps into each other at the centre or core, and no bolt or screw is used in their construction, being built in separate pieces, and then laid up as drain tile is put together. You have by this method two separate stairways on one centre. These steps can be cast in halves, or whole sections; and when finished you have a fire-proof, smoke-proof and water-proof staircase. The stairs are constructed from the brick wall on the outside to the centre or core; the landing of the upper staircase making a ceiling, and fire and smoke-stop to the staircase below; so that no smoke or fire can come up from one series of staircases into those above. It is absolutely a solid construction, these staircases; as separate as if built in two buildings. Therefore the water that goes down on an upper staircase cannot reach the one below it; the steps being grooved or ringed into each other with the ends cemented into the brick walls of the tower. There are two models of the steps used in construction of the stairways. The only place where you need use a screw or bolt in the whole construction is where you put in the platforms and the upright divisions, or fire-stops; so that any first-class mason or machinist can take these pieces and construct the tower. With the compartment construction, and this fire-proof staircase I claim — and Mr. DAMRELL, Inspector of Buildings of this city, indorses the statement, only in a larger degree — fifty per cent of the loss by fire in a mill will be saved. You understand that with the large air spaces of a mill undivided, the fire that has taken possession in one room soon becomes so intense that it bursts out; and very soon becomes a conflagration over which there is no possible control. You cannot put water enough on to the fire to put it out, therefore everything is destroyed, and there is nothing to prevent the fire from spreading throughout the

structure. To make the building still safer, every one of the windows should be protected; which can be very easily done by several different methods. This completes the description of the single tower, which you understand is planned for a three-story mill.

Now for a four or five story mill, we take this form (illustrating by a second model). Instead of going to the expense of building this size of tower all the way up, we carry up in the centre the tower above described, with eight-inch walls, and the outside section of this tower with twelve-inch walls. You see there is the inside staircase, made for the fourth and fifth stories in that form, entirely enclosed for three stories and having an exit through a fire-proof vestibule at the ground, the other exits being made at different points. This is the best form because it is more simple in construction. In planning the tower we had to meet this question: how are we to fire proof all the stairways in so large a tower? Simply by building an eight-inch division wall from the ground close by each entrance, to the centre of the tower. We will call this the room in which you make the exit, right in here; and the eight-inch wall, which can be built at a very small expense, completes each one of these compartments. Here is a little model of the double staircase which can be constructed of either iron or bronze; the large model represents the full four or five story plan, and can be built complete within seventeen feet in diameter. A steel ceiling is placed on the walls of the tower, before the roof is put on; so that in case a chimney or any embattlement on the walls should fall, the firemen can safely remain in the tower. Standpipes for water can be placed in the tower with connections with every floor, making a permanent wate tower, and if the firemen are driven out of the building have a perfectly safe means of exit to the ground. W firemen reach the building they do not have to we erection of ladders, but can instantly go to eve these separate staircases.

You understand this will be smaller than th

tower of a factory building; but we think it is a good deal better for the manufacturer, and for the protection of the operatives, to multiply the towers and thus increase the means of escape and protection; so that in case of panic the inmates cannot be crowded upon one staircase.

I am very much obliged for your attention. If there are any questions you would like to ask, I would be happy to answer them.

Mr. WOODBURY. I would like to ask the speaker, if a man has to go from the fourth to the fifth story, would he have to go down to the ground on one staircase and then go up again?

Mr. CLARKE. You can have a third entrance to the tower if you care to; or you can make two or three entrances if you please. In one building in Springfield we put two fire-proof entrances to one staircase. We are not controlled at all in that respect. It is just as easily adapted, also, by carrying this platform around, as you can have two or three entrances to the same platform.

Mr. WOODBURY. That method of independent fire doors would make the conditions of fire hazard like those now existing in many mills where all the entrances to the stairway tower are provided with fire-proof doors; without, however, the great complication and expense of this construction.

(On motion of Mr. KNIGHT, the meeting was then adjourned.)